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2005 ANNUAL COMPREHENSIVE REPORT OF GROUND AND SURFACE WATER QUALITY KERR-McGEE CHEMICAL LLC SODA SPRINGS, IDAHO FACILITY

August 23, 2005

Prepared by:

GLOBAL ENVIRONMENTAL TECHNOLOGIES L.L.C.

2005 ANNUAL COMPREHENSIVE REPORT OF GROUND AND SURFACE WATER QUALITY

KERR-McGEE CHEMICAL LLC
SODA SPRINGS, IDAHO FACILITY

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August 19, 2005

Kerr-McGee Chemical LLC
P.O. Box 478
Soda Springs, Idaho 83276

Attn: Mr. Boyd Schvaneveldt
Plant Manager

RE: TRANSMITTAL: REMEDIAL ACTION 2005 ANNUAL COMPREHENSIVE REPORT OF GROUND WATER QUALITY FOR KERR-McGEE CHEMICAL LLC SODA SPRINGS, IDAHO FACILITY

Dear Mr. Schvaneveldt:

Enclosed please find transmitted the Remedial Action 2005 Annual Comprehensive Report of Ground Water Quality Kerr-McGee Chemical LLC Soda Springs, Idaho Facility. This document includes: 1) an evaluation of current (May 2005) ground water quality distribution at on- and off-site locations, including Ledger Springs; 2) an evaluation of ground water quality changes with time; 3) projections of concentration decay trends for selected COC and wells, and; 4) conclusions regarding the effects of LSE and reclamation efforts to date.

We appreciate the opportunity to work with you on this project. If you have any questions regarding this transmittal, please contact us.

Very truly yours,
Global Environmental Technologies, LLC

J. S. Brown

REGISTERED PROFESSIONAL GEOLOGIST
JOHN S. BROWN
8-19-05
NO. 721
STATE OF IDAHO

John S. Brown, P.G.
Principal/Owner

Attachments: Remedial Action 2005 Annual Comprehensive Report of Ground Water

xc:

Joe Derby (KMC LLC)
Russ Jones (KMC LLC)
Toni Ellington – (KMC LLC)
John Dixon – KMC LLC
Neil E. Thompson — EPA Region X – (4 copies)
Doug Tanner — IDEQ Pocatello
Dean Nygard — IDEQ Boise

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1.0 INTRODUCTION

1.1 Ground Water Monitoring Program

Kerr-McGee Chemical LLC (KMC LLC) monitors water levels and water quality in both on- and off-site wells and springs on a semiannual basis. Data reports are presented to the EPA and IDEQ on a semiannual basis. A validation report that included the Remedial Design/Remedial Action (RD/RA) database was issued to EPA on March 4, 2005 (GET, 2005). Therefore, the database is not included in this report, and the reader should refer to the data contained in the validation report in conjunction with this document. The RD/RA database contains all analytical data supplied by the laboratory following the completion of the Remedial Investigation/Feasibility Study (RI/FS) study, and was prepared at the request of Region 10 EPA on September 23, 1997.

Monitor wells were installed at strategic locations to monitor specific surface water impoundments, aquifer units, downgradient off-site locations, and the KMC LLC facility as a whole. Locations of on- and off-site well placements and screen location depths are shown in Table 1-1. These data are also presented in previous technical memoranda and work plans (Dames & Moore, 1991 a, b and 1992).

Location of the KMC LLC site is shown on Figure 1-1. Locations of all KMC LLC wells installed during the remedial investigation (RI) are shown on Figure 1-2. Figure 1-2 also presents measured water level elevations and ground water gradients in May 2005.

Thirteen of the 18 RI/FS wells are designated "shallow" wells with total depths of 45 to 73 feet. Four wells are designated "intermediate-depth" wells with total depths of 100 to 173 feet. One well (KM-19) is completed on-site to a total depth of 230 feet and designated a "deep" well.

The shallow wells are completed with 10 feet of well screen that is set in the uppermost-defined basalt flow or interflow zone. Shallow wells were completed within the first occurrence of ground water while drilling. On-site shallow wells include wells KM-1, KM-2, KM-3, KM-4, KM-5, KM-6, KM-7, KM-8, KM-9, and KM-13. Off-site shallow wells include KM-15, KM-16, and KM-17.

The intermediate-depth wells are completed with 20 feet of well screen that is set in a deeper basalt flow identified across the site through geophysical interpretation. On-site intermediate depth wells include KM-10, KM-11, and KM-12. The off-site intermediate-depth well is designated KM-18.

1.2 Remedial Action Completion

A complete discussion of the Remedial Action Completion activities is described in the Draft Remedial Action Completion Report Revision I (GET, 1999), and the Draft Remedial Action Completion Report for Calcine Capping, 2000 through 2001 (GET, 2003). Remedial Action for the KMC LLC vanadium facility addressed the selected site remedy from the Record of Decision (ROD, September 1995) and subsequent amendment to the ROD (July 2000). The Remedial Action for the vanadium plant included:

- Elimination of uncontrolled liquid discharges from the site;
- Landfilling solids from the ponds at an on-site landfill;
- In-place capping of the wind-blown calcine, roaster reject, reject fertilizer, and active calcine tailings during 2000 and 2001;
- Semi-annual ground water monitoring to determine the effectiveness of source control, and;
- Establishment of institutional controls in affected off-site areas to prevent ingestion of ground water for as long as the ground water exceeds the risk-based concentrations (RBC).

1.2.1 Liquid Source Elimination

The ROD required KMC LLC to implement Liquid Source Elimination (LSE) to eliminate the uncontrolled releases of process water to ground water. During 1993, the unlined magnesium ammonium phosphate (MAP) ponds were removed from service and covered. This action had an immediate effect on water quality in nearby well KM-5. Three larger unlined ponds at the facility were either eliminated or replaced to accomplish LSE between 1995 and 1997. These three ponds included the roaster scrubber pond, S-X raffinate pond, and the calcine pond. Elimination of these ponds also had an effect on ground water quality

1.2.1.1 Scrubber Pond

Wet scrubbers controlled air emissions from the roasters since the plant began operating in 1963. The solids collected in the scrubbers and in the discharge water were pumped to various scrubber water ponds. This management practice resulted in an uncontrolled release of the process water to ground water, and left the solids from the process impounded in each pond. The scrubber sediments from the former pond on the east side of the facility were impounded in the on-site landfill, constructed during 1997.

The wet scrubbers were replaced by a baghouse system on each roaster in 1997. The baghouse collected particulate emissions without the use of water. Solids collected in the baghouse were impounded with the calcine. The result of the installation of the baghouse system was the elimination of the scrubber pond. This allowed for the excavation and placement of the roaster scrubber solids in the landfill and the closure and reclamation of the roaster scrubber pond.

The vanadium plant and supporting baghouse facilities were dismantled between October 2001 and February 2002. The footprint of the vanadium plant was covered with limestone fines and recontoured to provide positive drainage away from the site of the former facility.

1.2.1.2 S-X Pond

KMC LLC constructed double-lined ponds in 1995 and 1997 to contain the raffinate stream. The 5-acre ponds were reclaimed in 2004. Use of the unlined S-X pond was discontinued by 1996 and the sediment was pushed into a pile when the bottom was dry. The S-X pond sediments were impounded in the on-site constructed landfill in 1997.

1.2.1.3 Calcine Pond

Historically, calcine was deposited in the impoundment area by mixing the solids from the vanadium leaching process with water and pumping the slurry to the calcine impoundment. The water used in this operation infiltrated through unlined calcine ponds. KMC LLC installed a mechanical dewatering system to separate the water and the calcine in 1997, eliminating the pond. No calcine was produced following closure of the plant in 1999 and the calcine impoundment site was capped with synthetic liner in 2001.

1.3 LSE Completion

KMC LLC excavated and transported S-X and scrubber pond sludge to an engineered landfill constructed during September 1997. The S-X pond was taken out of service during 1996. During November 1996, the S-X pond sediments and underlying soils were scraped to the south end of the pond and covered with plastic. This allowed an extended period for the S-X solids to dry and consolidate. The scrubber pond came out of service in April 1997 and was drained prior to sediment thickness investigation.

The scrubber solids were worked into windrows and piles in the scrubber pond basin to accelerate drying. Prior to compaction in the landfill, the wastes were mixed at a ratio of 3:1 scrubber to S-X solids to achieve optimum moisture for compaction. During the last week of September 1997, the Idaho Department of Environmental Quality (IDEQ) inspected the pond basins and determined that all of the pond solids had been removed from the pond basins. Several feet of clean native soil were placed in the pond basins to support growth of a vegetative cover. The overall site slopes were graded and sloped to enhance runoff away from the preexisting pond locations.

Pond reclamation activities occurred during the last week of September and during the first week of October 1997. Following removal of sediment materials from the pond basins and approval of closure from the IDEQ, completeness of sediment removal from pond basins was documented with photographs.

1.4 Ground Water COC

The six contaminants of concern (COC) identified in the Risk Assessment (EPA, 1993) include arsenic, manganese, molybdenum, tributyl phosphate, total petroleum hydrocarbons, and vanadium. Table 1-2 presents a range of concentrations for COC at the POC wells, showing both the largest and the most recent (May 2005) concentrations.

2.0 SUMMARY OF SITE HYDROGEOLOGY

2.1 Site Hydrogeology

Ground water beneath and downgradient from the KMC LLC site exists within the basalt sequences, the basalt interflow zones, and within limited areas of the alluvium. Ground water also exists within the underlying Tertiary Salt Lake Formation. All of the on-site and off-site monitor wells installed as part of the KMC LLC RI/FS are completed at various depths within the basalts. Although ground water occurs in the Salt Lake Formation and within a limited area of the alluvium on-site, the basalts are considered the principal aquifer beneath the KMC LLC site.

The hydrogeologic properties of the basalts and interflow zones were characterized for the KMC LLC RI/FS, using:

- Geologic, geophysical, hydraulic head, hydraulic gradient, and hydraulic conductivity parameters from the installed wells;
- Hydraulic response data observed in the monitor wells, and;
- Observation and testing data from 14 on-site monitor wells, 4 off-site monitor wells and 5 on-site coreholes.

2.1.1 The Salt Lake Formation

The Tertiary Salt Lake Formation is comprised of tuffaceous sandstones, conglomerates and limestones that yield small amounts of ground water for domestic and stock purposes, and are unpredictable as a water-supply source. The Salt Lake Formation is not considered part of the shallow ground water system. The Salt Lake Formation was cored on-site in corehole CH-3 from 231 to 250 feet (total depth of corehole CH-3) and was found to consist of fractured quartzite, sandstone, and clay with a packer test hydraulic conductivity of 0.77 ft/day. This is within, but at the low end of the range of packer-test hydraulic conductivities estimated for the deeper part of the overlying basalt sequence. No wells at the KMC LLC site were completed within this formation.

2.1.2 Alluvium

Seismic refraction studies performed as part of the RI indicated that alluvium is thickest and extends to the greatest depth on the eastern side of the plant facility. Based on geologic data from well KM-2, a small area of thin saturated alluvium overlies the basalt in the eastern part of the KMC LLC facility where the elevation of the basalt/alluvium contact falls below the elevation of the water table. Well KM-2 is screened across the basalt/alluvium contact. The area of saturated alluvium appears to be limited near the east side of the facility, extending a short distance to the north and south of the capped calcine tailings. The alluvium has not been noted to contain ground water at other locations on the KMC LLC site.

2.1.3 Basalt Aquifer

The basalts and interflow zones of the mid-Pleistocene Blackfoot Lava Field comprise the principal aquifer at the KMC LLC site. All of the on-site KMC LLC monitor wells, with the exception of well KM-2, are screened exclusively within these basalts and interflow zones. The basalt sequence at the KMC LLC site, described in the RI is comprised of five identifiable basalt flows (Basalts Nos. Qb_1 through Qb_5) and associated interflow zones (Interflow Zones Nos. I_1 through I_4). Two younger basalts (Qb_{5a} and Qb_{5b}) and associated interflows were identified to the south and west of the site and are believed to have occurred as post-faulting flows. These basalts and interflow zones are believed to be stratigraphically similar to basalt flows identified at the Monsanto Site by Golder (1985 and 1992a). However, the hydrogeologic characteristics of the basalt flows between the two sites appear to be different. Notable differences include:

- Magnitudes of hydraulic conductivities of the basalt flows and interflow zones at the KMC LLC site are relatively similar based on the results of extensive aquifer testing, whereas basalts and interflow units at the Monsanto site are indicated to differ substantially;

- Local water level elevation and water quality differences exist between adjacent shallow, intermediate-depth and deep wells at Monsanto. Water quality and aquifer test data for KMC LLC indicate that the entire thickness of saturated basalt is in relatively good vertical hydraulic connection over the area of the KMC LLC site, and;

- Faults are considered to represent zones of increased transmissivity at the KMC LLC site, whereas they are interpreted to be barriers to flow at the Monsanto site.

2.1.3.1 Hydraulic Conductivities of the Basalt Aquifer

Primary permeability of unbroken basalt is small. Most ground water in basalt is transmitted along secondary features such as joints or fractures. Vertical columnar joints are a common feature observed in basalt exposed to the south and southwest of the site along the trace of the Finch Spring Fault. The presence of intensely fractured or vesicular zones, rubble zones, and/or cinder zones can also greatly increase the ability of basalt to transmit water. Interflow zones are comprised of subaerial deposited materials, including clays, cinderaceous deposits, alluvial sands and gravels, organic debris and weathered and broken basalt. Variations in the ability of interflow zones to transmit water result from changes in the character and thickness of these materials.

Observed hydraulic conductivities estimated from the slug, specific capacity, and pumping tests conducted in the shallow, intermediate-depth, and deep wells include the following:

- Basalts ranged from 8 to 340 ft/day;

- Interflow zones ranged from 90 to more than 200 ft/day.

- Basalts and interflow zones together ranged from 2 to more than 100 ft/day.

- Basalt No. Qb_5 (shallow basalt represented by shallow well screened zones) ranged from about 9 to 340 ft/day.

- Basalt No. Qb_3 (Deeper basalt screened in wells KM-10, KM-11, KM-12, and KM-18) ranged from 8 to almost 100 ft/day.

Hydraulic conductivities estimated for well KM-19 screened in Basalt No. Qb_2 and Interflow Zone No. I_1 ranged from about 15 to almost 70 ft/day.

Generalizations about hydraulic conductivities observed within the basalt aquifer at the KMC LLC site include the following:

- The hydraulic conductivities of interflow zones are not significantly greater than those of the basalt flows;
- Hydraulic conductivities of the shallower basalts (Basalt No. Qb_5) are generally greater but not significantly greater than those of the deeper basalts (Basalt No. Qb_3);
- A horizontal layer of significantly smaller hydraulic conductivity which could greatly limit or prevent vertical movement of ground water was not identified;
- A continuous horizontal layer of significantly larger hydraulic conductivity along which horizontal ground water flow could be localized was not identified;
- Hydraulic conductivities in the shallow wells on the east side of the plant (KM-1, KM-2, KM-3, and KM-4) range from 90 to 270 ft/day and appear to be greater than hydraulic conductivities in shallow wells on the west side of the plant (KM-5, KM-8, KM-9, and KM-13), which range from 9 to 48 ft/day.

2.1.3.2 Estimated Ground Water Velocities

Horizontal hydraulic gradients within the shallower basalt aquifer vary from 0.01 feet per foot in the eastern part of the site to 0.03 feet per foot in the western part of the site. Effective porosities have been reported for the basalts of the Snake River Plain aquifer of southeastern Idaho to range from about 8 to 10 percent (Robertson, 1974; Lewis and Goldstein, 1982; Isherwood, 1981; Nace et al., 1959). If an effective porosity of 8 percent and range of hydraulic conductivities of 5 to 270 ft/day is used, then a range of estimated ground water particle velocities of 0.6 to 34 ft/day can be calculated for the eastern part of the plant site. The effective porosity of 8 percent and the observed range of hydraulic conductivities of 9 to 340 ft/day on the western of the site yield a range of estimated ground water particle velocities of 3 to 130 ft/day for the western part of the plant site.

2.2 Current Direction and Rate of Ground Water Flow

Ground water flows in response to hydraulic gradients from areas of higher hydraulic head to areas of lower hydraulic head at rates that are proportional to hydraulic conductivity and hydraulic gradient and inversely proportional to effective porosity of the aquifer. Ground water can flow vertically through aquifers or between aquifers in response to vertical hydraulic gradients and horizontally within aquifers in response to horizontal gradients. Ground water in the Shallow Aquifer System generally flows southward from the topographically higher Blackfoot Reservoir (about 12 miles north of the KMC LLC facility) to seeps and springs along the topographically lower Bear River.

Horizontal hydraulic gradients and ground water flow directions within the shallow basalt units at the site are indicated by water level elevations measured during May 2005 and are contoured on Figure 1-2. Overall, water levels dropped on average 5 to 8 feet between 1997 and 2004, as indicated on Figure 1-3. Water levels are typically higher by about 2 to 3 feet in the spring and lower in the fall. Water level elevations decreased most notably between 1998 and 2001. Water levels in May 2005 recovered to about 2001 levels.

Figure 1-3 also indicates that KM-8 has a lower head than its two deeper adjacent wells KM-12 and KM-19, indicating an upward vertical gradient in this area. This difference in heads between the three wells has become less with time, which could be the result of the decreased salinity in KM-8.

The predominant flow direction beneath the plant site is to the west-southwesterly, as shown on Figure 1-2. The western ground water flow direction beneath the site is caused by pumping from the Monsanto production wells located west of the KMC LLC site. Ground water levels beneath the east side of the facility suggest a more southerly flow component, with flow beneath the east side of the facility directed towards well KM-3. This subtle change in flow direction may be the result of capping the calcine in 2001.

Previous annual evaluations indicated a flatter and more westerly overall flow pattern for this area.

Water level elevations measured during May 2005 in the deeper monitor wells KM-11, KM-12, and KM-18 are also shown on Figure 1-2 but are not contoured. Ground water levels in the deeper wells indicate a pattern of ground water flow that is similar to the pattern observed in the shallow wells.

3.0 GROUND WATER SAMPLING

3.1 Ground Water Point of Compliance

The Record of Decision (EPA, September 1995) states that the point of compliance (POC) for the evaluation of the selected remedial actions for ground water will be the boundary of the current active industrial facility, using the existing monitoring wells (EPA, 1995). During the RI, KMC LLC placed monitor wells at strategic locations to monitor specific impoundments, aquifer units, downgradient off-site locations, and the facility as a whole. Locations of on- and off-site well placements and screen location depths were presented in previous technical memoranda and work plans.

During 2004, KMC LLC purchased the Hopkins property to the south of the former industrial facility. This property includes the areas containing the monitoring wells KM-15, KM-16, KM-17, and KM-18, that have been designated the "off-site" wells in all previous documents. The off-site designation is continued in this document, referring to wells that are located off of the industrial facility boundary, as established by EPA.

POC wells include wells KM-2, KM-3, KM-5, KM-8, KM-9, KM-11, KM-12, KM-13, and KM-19. EPA requested the addition of wells KM-2, KM-3 and KM-11 to the list in their May 6, 1997 correspondence and KMC LLC included POC sampling for these wells. Table 3-1 provides the justifications used for sampling of POC wells at the site, and for sampling off-site well and spring locations.

3.2 Ground Water Sampling and Analysis Plan

A ground and surface water sampling plan was developed for the RD/RA sampling events for on-going semiannual sampling. This plan was finalized and accepted by EPA during May 1997. An additional low-flow sampling plan was developed during September 1997 to incorporate low-flow sampling methods described below.

3.2.1 Low-Flow Purge Sampling Methods

KMC LLC installed stainless steel submersible pumps in each of the sampling wells during October 1997. A pump was installed in KM-7 during May 2000. These pumps are dedicated for evacuation and sampling purposes. Each pump is operated by a portable generator system. Each pump is suspended on Schedule 80 1-inch PVC piping and a stainless steel safety cable (in intermediate depth and deep wells), such that the intake level on each pump is placed in the approximate center of the well screened interval.

Low-flow well purging methods were first performed during the November 1997 sampling round following dedicated pump installation in each of the sampled wells. Low-flow sampling methods are based on EPA Region 1 "Low Flow SOP" dated May 13, 1996 and the EPA document "Low-Flow (Minimal Drawdown) Ground Water Sampling Procedures" dated April 1996. This method was provided as an addendum to the RD/RA Sampling and Analysis Plan (SAP) deliverable submitted to EPA during May 1997 and approved by Region 10 EPA on June 6, 1997. Low-flow sampling is performed on all of the "KM" series wells with the exception of non-POC wells KM-1 and KM-10. Wells KM-1 and KM-10 are monitored for water level purposes only.

During sampling, flow rates are measured concurrent with drawdown in each well to assess stabilization of purged ground water. A discharge assembly is used to control the rate of discharge from each well via use of a ball valve. The assembly is used to control discharge from each well during sampling such that the amount of discharge will not allow the well to be drawn down more than 0.3 feet during purging and sampling events.

Field measurements are made through the use of a turbidity meter and flow cell. The flow cell is used to measure pH, temperature, specific conductance, and dissolved oxygen. Field data are graphed following sample collection to show stabilization of field parameter measurements with time prior to sample collection. These graphs are presented with the semiannual data validation reports. Criteria used to determine whether the purged water has stabilized include:

- pH within ± 0.3 units;
- Temperature to within ± 2 degrees;
- Specific Conductance within ± 10 percent;
- Dissolved oxygen within ± 10 percent, and;
- Turbidity within ± 10 percent.

If the parameters do not stabilize to meet the above criteria within the extraction of three casing volumes, then a sample is obtained following the removal of not more than three casing volumes. Samples are collected from the discharge point beyond the ball valve. Samples are collected and handled in accordance with the May 1997 SAP.

3.3 QA/QC Data Review

QA/QC review is performed on a semiannual basis after receipt of the data from the lab. Results of the QA/QC data review are presented in the semiannual data validation report, and are not included in this annual ground water review.

4.0 RECENT GROUND AND SURFACE WATER QUALITY

Recent ground and surface water quality refers to the results of samples obtained between the dates of May 3 through May 4, 2005 the (May 2005 sampling round).

4.1 Background Water Quality and Type

Upgradient off-site springs and wells were sampled during the RI, but are no longer sampled. The reader is encouraged to refer to the RI report (Dames & Moore, 1995). Locations sampled from background for the KMC LLC site included Formation Spring, and several other private wells to the north and east of the site. These locations have not been sampled since 1991.

TDS concentrations are about 500 mg/l in background wells and springs. The largest reported TDS concentration from background locations was 579 mg/l in Formation Spring. The pH values measured at the background locations are near neutral and ranged from 6.8 to 7.4 units. Specific conductance ranged from about 840 umhos/cm in the private wells to about 970 umhos/cm in Formation Spring.

Reported background chloride concentrations are about 3.9 mg/l. Background sulfate concentrations are in the range of about 40 mg/l. Nitrate concentrations range from 0.11 mg/l in Formation Spring to 0.75 mg/l in private wells. Concentrations of aluminum, arsenic, chromium, manganese, molybdenum, nickel, selenium, and vanadium are less than detection at upgradient private wells and springs.

Background ground water quality and type was characterized during the RI using the trilinear diagram classification method developed by Piper (1944). The Piper diagram consists of two ternary fields (triangles) for plotting percentages of cations (left triangle) and anions (right triangle), and a central diamond-shaped composite field for plotting the relative contribution of the major ion pairs. Based on the Piper plots, the site background water type plots in a specific pattern and can be classified as calcium-magnesium bicarbonate-type water.

4.2 Common Ion Distributions in Ground Water

The Piper plots evaluated during the RI indicated a mixing of background-type waters beneath the site with pond seepage and contributions from leachate produced in the vadose zone. Water flowing onto the site is relatively high in calcium and low in sodium and potassium. Waters are also compositionally high in bicarbonate. Waters mixed beneath the site increase substantially in sodium, potassium, sulfate and chloride (Dames & Moore, 1995).

4.3 General Ground Water Quality Parameters

4.3.1 pH

The pH range in wells across the site historically indicated neutral to slightly alkaline conditions in the past. Between 1999 and 2001, field pH was found to be lower in many of the wells near the reclaimed S-X pond including samples from wells KM-6, KM-7, KM-8, KM-12, KM-19, and near the reclaimed scrubber pond (KM-2, KM-3, KM-4, and KM-11). The lower ground water pH (range of 6.1 to 6.9) likely had some affect on concentration trends for metals during the 1999 through 2001 period, causing small metals concentration increases during this period. Site distribution of pH is shown on Figure 4-1. During the May 2005 sampling event, pH was in the near- neutral range across the site.

4.3.2 Total Dissolved Solids

Ground water TDS concentrations in on-site wells ranged from slightly less than 500 mg/l in wells KM-1 and KM-10 (previous results) to about 11,000 mg/l (current) in well KM-8. The secondary drinking water standard for TDS (500 mg/l) was exceeded in most of the KMC LLC POC wells. Recent concentrations of TDS are elevated in shallow wells KM-2 (1,300 mg/l), KM-3 (3,800 mg/l), and KM-4 (2,200 mg/l) which surround the reclaimed scrubber pond, located to the south of the calcine tailing area that was capped in 2001. TDS concentrations in well KM-8 (12,000 mg/l) is substantially larger than other site concentrations, while nearby wells KM-9 (550 mg/l) and KM-13 (540 mg/l) are closer to background concentrations. Concentrations of TDS in intermediate-depth and deeper wells are elevated above background in KM-11 near the reclaimed scrubber pond (600 mg/l) and at KM-12 (640 mg/l) near the S-X pond. TDS in deep well KM-19 (470 mg/l) is within the range of background.

TDS concentrations are elevated in wells located south and southwest of the KMC LLC site, including off-site wells KM-15 (610 mg/l), KM-18 (610 mg/l), KM-16 (730 mg/l), and KM-17 (990 mg/l). Finch Spring located approximately 4400 feet south of the KMC LLC site currently has a TDS concentration of 580 mg/l.

4.3.3 Turbidity

Turbidity was measured in the field during low-flow purging of the wells. Results of turbidity for the May and October 2001 sampling events are summarized in Table 3-2 and presented graphically in Appendix A of the May 2005 Laboratory Data Quality Report (GET, February 2003). Although turbidity is generally not considered indicators of ground water contamination, excessive turbidity in an unfiltered sample can bias analytical results causing reported total metals concentrations to be not representative of true concentrations in ground water. Turbidity is a measure of the solids and suspended organic material in a sample and is reported in nephelometric turbidity units (NTUs).

May and May 2005 turbidity ranged from 0.40 NTUs in well KM-16 to 34 NTUs in well KM-8. Well KM-8 frequently exhibited increased turbidity throughout its sampling history. Turbidity was reduced following redevelopment and removal of large amounts of sediment from this well in February 2000.

4.4 Selected Major Ions in Ground Water

4.4.1 Chloride

Chloride concentrations continue to decrease with time. The secondary drinking water standard for chloride is 250 mg/l. Reported chloride concentrations in shallow wells range from 5.7 mg/l in KM-1 (previous sampling) to 2,400 mg/l (recent) in KM-8. Chloride was predominant in the S-X stream and scrubber pond before these ponds were removed from service. May 2005 concentrations of chloride are elevated relative to background in shallow wells KM-2 (370 mg/l), KM-3 (1,100 mg/l), and KM-4 (570 mg/l), all located near the reclaimed scrubber pond. Wells KM-9 and KM-13, located to the southwest and west of the S-X pond, respectively have near-background chloride concentrations of 24 and 27 mg/l. Well KM-5 also indicates slightly elevated chloride concentrations (62 mg/l). Chloride concentrations are slightly elevated to the south and southwest of the site at several sampling locations, including off-site wells KM-15 (40 mg/l), KM-16 (75 mg/l), and KM-17 (120 mg/l).

Concentrations of chloride in deeper wells are also elevated, including KM-11 near the former scrubber pond (44 mg/l) and in well KM-12 (53 mg/l) near the former S-X pond. Deep well KM-19 (9.2 mg/l) is at background levels. Chloride concentrations at Upper and Lower Ledger Springs was 4.4 to 4.6 mg/l represent background levels.

4.4.2 Nitrate Plus Nitrite

Prior to the October 1995 sampling round, samples were analyzed for nitrate, nitrite, and nitrate plus nitrite. Nitrite concentrations are relatively small in comparison with nitrate. Currently, only nitrate plus nitrite is analyzed. The primary drinking water standard of for nitrate is 10 mg/l. Nitrate plus nitrite concentrations at Upper and Lower Ledger Springs is currently 0.41 to 0.46 mg/l, near background.

Nitrate plus nitrite concentrations appear to be decreasing with time, although a rise in concentration is noted at several occasions during the May 2005 sampling round. Recent concentrations in shallow wells and off-site locations range from 1.5 mg/l in well KM-3 to 38 mg/l in well KM-8 near the reclaimed S-X pond. Nitrate plus nitrite concentrations are elevated above background in the area of the reclaimed scrubber pond in wells KM-2 (5.4 mg/l) and KM-4 (17 mg/l). Well KM-6 also has slightly elevated nitrate plus nitrite concentrations of 6.5 mg/l. Nitrate plus nitrite was detected to the south and southwest of the site at several sampling locations, including off-site wells KM-15 (9.4 mg/l), KM-16 (7.2 mg/l), and Finch Spring (3.6 mg/l).

4.4.3 Sulfate

Sulfate concentrations are also decreasing with time, showing similar decreasing trends to chloride and TDS. Reported concentrations of sulfate from the May 2005 sample round range from about 36 mg/l in well KM-19 to 7,900 mg/l in well KM-8. The secondary drinking water standard for sulfate (250 mg/l) was exceeded in monitor wells KM-2, KM-3, KM-4, and KM-8. The largest sulfate concentrations are associated with infiltration from the former S-X raffinate stream.

Recent sulfate concentrations are elevated relative to background in shallow wells KM-2 (260 mg/l), KM-3 (1,600 mg/l), and KM-4 (630 mg/l), which surround the reclaimed scrubber pond. Well KM-8 (7,900 mg/l) located near the former S-X pond also has the largest sulfate concentrations on-site. Well KM-9 and KM-13, have smaller concentrations of sulfate than other wells near the former S-X pond at concentrations of 76 and 82 mg/l, respectively. Off-site concentrations of sulfate are elevated above background in off-site wells KM-15 (120 mg/l), KM-16 (160 mg/l) and KM-17 (170 mg/l). At paired off-site shallow wells KM-15 and intermediate-depth well KM-18, sulfate concentrations are nearly identical.

Sulfate concentrations in the deeper wells are elevated in KM-11 near the scrubber pond (110 mg/l) and in KM-12 (160 mg/l) near the former S-X pond. Deep well KM-19 (36 mg/l) is slightly elevated with respect to background concentration.

4.5 Selected Metals in Ground Water

4.5.1 Arsenic

Recent ranges of arsenic concentrations in KMC LLC monitor wells are summarized in Table 1-2 and are shown on Figure 4-2. Concentrations in ground water range from less than detection in on-site wells to 82 ug/l in well KM-8. Samples collected from off-site springs were less than detection. Recent distribution of arsenic in on-site wells shows that arsenic is detected in wells around the reclaimed scrubber pond up to 17 ug/l in KM-3, and 82 ug/l in well KM-8 near the reclaimed S-X pond.

4.5.2 Manganese

Manganese concentrations are decreasing with time in nearly all of the wells. Recent manganese concentrations in KMC LLC monitor wells are summarized in Table 1-2, and are shown on Figure 4-3. Recent manganese concentrations in ground water for on-site wells range from less than detection in well KM-19 to 3,000 ug/l in well KM-8. The RBC for manganese (180 ug/l) was exceeded during 2003 in two POC wells, KM-3 (530 ug/l) and KM-8 (3,000 ug/l). Manganese does not exceed the RBC at off-site well locations. Manganese was reported to be less than the detection limit at Upper and Lower Ledger Springs, Finch and Big Springs during May 2005.

4.5.3 Molybdenum

Molybdenum concentrations indicate an overall decreasing trend with time. Recent molybdenum concentrations in KMC LLC monitor wells are summarized in Table 1-2 and are evaluated on Figure 4-4. Molybdenum was a dominant metal in the S-X raffinate stream, and therefore is found in larger ground water concentrations near former releases from this source. On-site well concentrations of molybdenum during May 2005 ranged from 21ug/l in well KM-19 to 49,000 ug/l in well KM-8. Figure 4-4 illustrates that concentrations of molybdenum are elevated in areas near the former S-X and scrubber ponds. Molybdenum exceeds the RBC (180 ug/l) in all of the on-site wells with the exception of well KM-19. Previous reports predicted that molybdenum would fall below the RBC for wells KM-5 and KM-9 in 2003, based on projected trends shown in previous annual ground water reports. The molybdenum RBC is exceeded at all off-site KMC LLC well locations, and surface water sites Finch and Big Spring. Molybdenum was less than the detection limit to 2.6 ug/l in Upper and Lower Ledger Springs during May 2005.

4.5.4 Vanadium

Vanadium concentrations appear to be decreasing with time, but at a slower rate of decrease than arsenic, manganese, and molybdenum. Recent vanadium concentrations in the KMC LLC monitor wells are summarized in Table 1-2 and are plotted on Figure 4-5 for May 2005. Vanadium was a dominant metal in the S-X raffinate stream, detected at concentrations above the RBC (260 ug/l) in all of the on-site wells with the exceptions of intermediate well KM-11 and deep well KM-19. Vanadium concentrations range from 10 ug/l in KM-11 to 17,000 ug/l in well KM-8. Figure 4-5 illustrates similar trends to the distribution of molybdenum, with the larger concentrations identified near the south end of the reclaimed S-X pond and west of the scrubber pond area. Vanadium concentrations in off-site KMC LLC monitor wells located southwest of the site exceed the vanadium RBC. Off-site well KM-17 is less than the RBC.

During May 2005, the vanadium concentration in Finch Spring was elevated (61 ug/l). Vanadium was less than the detection limit of 10 ug/l in Upper and Lower Ledger Springs.

4.6 Organic Compounds in Ground Water

As noted during the RI (Dames & Moore, 1995), COC organic compounds that include tribally phosphate (TBP) and total petroleum hydrocarbons (TPH) originated from the No. 1 fuel oil carrier used in the solvent extraction process and found in the S-X raffinate stream. These compounds were detected in the former ponds and in the ground water. POC wells were sampled for total petroleum hydrocarbons and for semi volatile compounds for the detection of TBP through 1999. Organics were sampled in all POC wells in May/June 2002 as requested by EPA for evaluation in the 5-year review. Organics are not sampled at off-site locations. Previously, only well KM-8 was sampled for organics because other wells were less than detection (see Table 3-1).

4.6.1 Total Petroleum Hydrocarbons

TPH provides screening level estimates of total organic compound concentrations within certain hydrocarbon ranges but does not identify or provide concentrations of specific organic compounds. TPH was analyzed using Method 418.1 through 1999. This method could no longer be used because Freon was discontinued for use in the method by federal regulation. During the May 2005 sampling round, TPH was analyzed using a different extraction under Method SW846 8015B that included analysis for a range of C_{10} through C_{36}.

Recent TPH concentrations in POC monitor well KM-8 are summarized in Table 1-2. TPH concentration in KM-8 during the May 2005 sampling event was 1.1 mg/l, greater than the RBC (0.73 mg/l), but less than previous results for this well.

4.6.2 Tributyl Phosphate

TBP was used in the S-X raffinate stream and was detected at concentrations above the RBC (180 ug/l) in the wells near the reclaimed S-X and scrubber ponds during 1997. Results of previous analyses in off-site wells suggest that TBP does not exceed the RBC downgradient of the plant facility boundary. During a number of sampling events, TBP was not detected. During 1999, TBP was detected only in well KM-8 at 1400 ug/l. During 2000 and 2001, TBP was not detected in well KM-8. It is probable that some of the unknown compounds in KM-8 may be the result of degradation of the TBP compound. Currently, TBP has been identified in KM-8 at 240 ug/l.

5.0 CONCENTRATION TRENDS WITH TIME

5.1 General

Plots of concentration versus time are shown on the graphs presented in Appendix A. These graphs of routinely sampled well and spring sites present common ion and general indicator trends, including pH, chloride, nitrate plus nitrite, sulfate, and total dissolved solids. Graphs of metals concentrations include COC parameters of arsenic, manganese, molybdenum, and vanadium. During 2005, graphed organic parameters include TBP and TPH from well KM-8 only.

The charts in Appendix A are annotated, where appropriate, to show periods of pond operation, the approximate time that liquid source elimination (LSE) was implemented, and the time that calcine capping was performed. Observed increases and decreases in ground water concentrations shown on the plots result from:

- Process changes caused increases or decreases during pond operation;
- Liquid source elimination (LSE), removal of pond sediments and pond reclamation;
- Changes in ground water pH;
- Changes in water ground water levels, and subsequent gradients;
- Advective transport and natural attenuation in the aquifer.

Significant process change events are annotated on the graphs of concentration versus time for the wells. Table 5-1 provides a chronology of process and process pond events, and other site events that may have contributed to increasing or decreasing concentrations in the wells.

5.1.1 Fate and Transport of Graphed Chemical Parameters

Inorganic constituents evaluated versus time include metals, common ions, and TPH. Constituents can be non-reactive and move through the ground water, unaffected by biotic (metabolism, such as microorganisms) and abiotic (adsorption, ion exchange, precipitation, hydrolysis, redox) processes. The fate of specific compounds ultimately depends on the reactivity or non-reactivity of the chemical with the media during transport.

Common Ions

Graphs of the non-reactive chemicals include chloride, a member of the halogen group that is one of the most commonly detected anions in natural water. The transport of chloride through the ground water is largely through physical (hydrodynamic) processes. Chlorides travel at essentially the same rate as the ground water (Knox et al., 1993); the graphs indicate that chloride concentration changes quickly to modification in plant operations, LSE and reclamation efforts. Chloride ions can form complexes with a few of the positively charged ionic species, however, these complexes are usually weak, and are generally considered insignificant unless chloride concentrations are very large (Hem, 1978). Chloride is considered one of the best tracer elements, and is widely used experimentally in tracer models. In general, chloride does not enter into reduction/oxidation (redox) reactions, does not form solute complexes with other ions, does not adsorb to mineral surfaces and does not form salts of low solubility.

In the absence of plant growth, nitrate behaves as a mobile anion, similar to chloride (Drever, 1988). Nitrate concentrations can be rapidly reduced in surface waters through assimilation by aquatic plants (National Academy of Sciences, 1977). Attenuating factors for nitrates do not appear significant at the site, and concentrations may be reduced primarily through dilution in the aquifer.

The sulfate ion is chemically stable, and forms salts of low solubility with only a few metals (Hem, 1978). Once sulfate has dissolved in water, it generally remains in solution except where it is anaerobically reduced to sulfide, precipitated in sediment, released to the atmosphere, or incorporated into living organic matter.

Metals

Several processes interact to control the reactivity and rate of transport of compounds in ground water. Metal ions can be strongly adsorbed to mineral surfaces in a porous medium (such as a clayey interflow zone in a basalt sequence), or to rock surfaces exposed by fractures. On the other hand, this would inhibit their transport through the aquifer when complexed with other ions; some metals can be transported at average velocities that are orders of magnitude faster than when not complexed because of changes in the attenuation properties for the complexed metal.

Changes in speciation and reactivity can result from encountering different chemistries within the aquifer. The mobilities of different oxidation states of metals such as arsenic, manganese, molybdenum, and vanadium may also differ by order of magnitude (Allen et al., 1993).

In solution at neutral pH, the stable forms of arsenic would be arsenate oxyanions (Hem, 1978), with the dominant form being dependant on the pH of the water. Inorganic factors that maintain low concentrations of arsenic in water include adsorption by hydrous iron oxide, co-precipitation or combination with sulfide.

The transport and partitioning of manganese in water is controlled by the solubility of the specific chemical form of manganese that is present (USHHS, 1990). The solubility and speciation of manganese oxides in solution is largely a function of pH and redox potential. Manganese can also be subject to microbial activity. The principal anion associated with manganese is carbonate, although in waters with large bicarbonate concentrations, manganese bicarbonate complexes can be formed. In waters containing an excess of

1000 mg/l sulfate, manganese sulfate may become the dominant species. In extremely reduced water, the fate of manganese tends to be controlled by the formation of poorly soluble sulfide (USHHS, 1990). The tendency for soluble manganese to adsorb to soils and sediments depends largely on the cation exchange capacity and the organic composition of the soil (USHHS, 1990). Soil adsorption for manganese may be significant in the soils at the site, can be highly variable and can span five orders of magnitude, increasing as a function of organic content and ionic exchange capacity with the soil (Baes and Sharp, 1983). At small concentrations, manganese may become fixed by clays, whereas, at larger concentrations manganese may be desorbed by ion exchange with other ions in solution (USHHS, 1990).

Molybdenum is readily soluble in water, and is likely to be more mobile than vanadium in the ground water. Multiple valence states are a complicating factor in molybdenum chemistry. The anionic (molybdate) species are probably predominant in natural water (Hem, 1978).

Vanadium in the ground water at the site is predominantly found in the pentavalent state. Transport of vanadium in water and soil is influenced by redox potential, pH, and the presence of particulate (USHHS, 1990). Vanadium species have a tendency to bind strongly to mineral or biogenic surfaces by adsorption or complexing; hence it can be transported either in solution or in suspension. Adsorption may be the most significant attenuating factor at the site.

5.2 Trends for On-site and Point of Compliance Wells

5.2.1 Common Ions and General Indicators

Parameters including TDS, sulfate, and chloride indicate similar decreasing trends at the on-site non-compliance and POC wells. The pH is also a general indicator that may be affecting metals trends and concentrations noted at some locations in the past.

Based on a review of concentrations versus time for these parameters, the following general observations are made:

pH

Ground water in the vicinity of the reclaimed scrubber pond had neutral to slightly alkaline pH values through early 1999, relatively unaffected by process waters during plant operation or LSE. Following the summer of 1999, a general decrease in pH was noted in the shallow ground water through 2001 and in a few wells in 2002. The pH rose in these wells following 2002 to the neutral range in 2003. Current trends indicate the ground water beneath the site is in the near-neutral range.

TDS

TDS concentration trends for wells located near the former pond facilities are contained in Appendix A. Wells located near the former scrubber pond indicate an increase in TDS concentrations through 1993 to 1995 and then show general decreases to the present, with a flattening but decreasing trend for wells between 2000 and the present. Increases in TDS concentrations between 1993 and 1995 are attributed to the diverted discharge of the S-X stream into the scrubber pond instead of discharging to the S-X pond. During 1997, the scrubber pond liquid was pumped to the calcine pond in preparation of the scheduled remedial action for this facility. Incidental residual liquid in the scrubber pond was released from the pond near the location of well KM-3 during the stabilization of the scrubber pond solids. As a result, well KM-3 TDS concentrations spiked during 1997 from the effects of the residual liquid ponding at the surface in the near vicinity of the well. TDS concentrations have decreased since November 1997 following pond closure and reclamation, but appear to show seasonal variability between 2000 and the present, unlike other shallow wells in this area.

Shallow wells near the former scrubber pond demonstrated a greater degree of variability in TDS concentrations between sampling events prior to pond closure. All wells continue to decrease slightly in 2005. Seasonal increasing/decreasing trends may account for some of the variability between rounds. Intermediate depth well KM-11 demonstrated little variability.

Wells KM-5, KM-9, KM-12, and KM-13 located near the west side of the facility or near the reclaimed S-X pond indicate a general concentration decrease in TDS with time, and smaller overall decreases following 2000 as concentrations approach background. Well KM-6 indicated slightly increasing concentrations through 1999, followed by a decreasing TDS trend through 2002, and a flattening of the trend to the present. Deep well KM-19 is near background concentration. Well KM-8 indicates substantial variability with time, and suggests an overall decreasing trend since 1995. Seasonal increasing/decreasing trends may account for some of the variability between rounds.

Chloride

Chloride concentration trends for wells located near the former pond facilities are contained in Appendix A. Ground water in the vicinity of the reclaimed scrubber pond shows an increase in chloride concentration for shallow wells during pond operation through 1995 as a result of S-X stream discharges to this location, and then a decrease in chloride concentrations to the present. Shallow wells display variable chloride concentrations through 1997 between sampling events as the result of unlined pond operations, while intermediate depth well KM-11 is less affected and indicates a more even (smoother) trend with time that was less affected by pond operational changes. All wells in this area demonstrate decreases in chloride concentrations since November 1997 to the present. Well KM-3 remains relatively unchanged with some seasonality in the data since 2000, but slightly decreasing trends. The decreasing chloride trend in KM-2 slowed after 2003. Chloride concentration trends are nearly identical to TDS trends.

Wells located near the west side of the facility or near the former reclaimed S-X pond indicate chloride concentration decreases with time, with a general flattening of the trends since 2001. Well KM-6 chloride concentrations are also decreasing, but remain elevated above other wells in this area. Well KM-8 chloride concentrations show seasonal variability, but a general decrease in concentration through 2000, followed by a flattening of the trend and lack of seasonality in the data to the present. Prior to 2001, increased chloride concentrations occurred in the fall during periods of lower water level elevation in KM-8.

Sulfate

Sulfate concentration trends for wells located near the former pond facilities are contained in Appendix A. Sulfate trends for wells located near the reclaimed scrubber pond show decreasing trends that are comparable to chloride. An increase is noted in sulfate concentrations through 1996 as a result of S-X stream discharges to this location. Sulfate shows a general decrease to the present. Concentration increases in well KM-3 in 1997 resulted from incidental residual liquid in the scrubber pond that was released from the pond during remediation and reclamation. As the direct result, concentrations of sulfate in well KM-3 spiked during 1997. KM-3 sulfate concentrations decreased since that time, although the trend flattened somewhat since 2000. Sulfate concentrations in wells KM-2 and KM-11 have been relatively steady since 1999. Sulfate concentrations in well KM-4 have also indicated decreasing concentration trends since 1997. Well KM-11 was less affected by plant operations, and shows an even (smoother) trend with time and a longer duration of peak sulfate concentrations.

Wells KM-5, KM-9, KM-12, and KM-13 near the west side of the facility or near the former S-X pond indicate a concentration decrease with time with a flattening since 2000. Well KM-6 indicated little change with time through 2000, and then began to decrease to the present level. Well KM-19 sulfate concentrations decreased to near background concentrations in 1998. Well KM-8 sulfate concentrations vary with time similar to chloride and TDS trends, and indicate decreasing trends between 1995 and 1999 following LSE. Less seasonal variability in concentration is noted between 1999 and the present. Increased concentrations were noted in the fall during periods of lower water level elevation in this well prior to mid-2000.

Nitrate plus Nitrite

Nitrate plus nitrite concentration trends for wells located near the former pond facilities are contained in Appendix A. Wells KM-3 and KM-11 located near the reclaimed scrubber pond show like concentrations and trends, and a relatively flat trend since LSE was implemented. Well KM-2 shows higher nitrate plus nitrite ground water concentrations than KM-3 and KM-11, with declining concentrations between 1999 and the present. Well KM-4 nitrate plus nitrite concentrations indicate slightly increasing concentrations since 2001.

Shallow wells near the west side of the facility or near the former S-X pond indicated a spike in nitrate plus nitrite concentration between 1993 and 1994 and variable concentrations with time. Most wells show a decrease in nitrate plus nitrite concentration between 1997 through May 2000 with lesser changes to 2005 Concentrations in KM-7 suggest an increasing trend between 2001 to the present. Deeper wells KM-12 and KM-19 indicate little change with time. Well KM-8 concentrations spiked in 1994 and 1997, and indicate a decreasing trend to the present. The overall nitrate plus nitrite trend for KM-8 appears to be decreasing following final reclamation of the S-X pond basin, although the trend has flattened between 1998 and increased between 2001 and 2004.

5.2.2 Metals Concentration Trends

Graphs of metal concentrations versus time include the group of metals identified by EPA as COC. COC metals versus time are presented in Appendix A and described in the following sections.

Arsenic

The risk based concentration (RBC) is 50 ug/L for arsenic is based on the ROD.. Based on the most current results, only KM-8 exceeds this standard.

On January 22, 2001, EPA adopted a new drinking water standard or maximum contaminant level (MCL) for arsenic of 10 ug/L or 0.010 mg/L. Public water systems must comply with the new standard by January 23, 2006. EPA will direct KMC LLC as to how or whether the new standard may be applied to POC wells.

Wells located near the former scrubber pond are below the RBC of 50 ug/l and indicate the following trends. Well KM-3 shows a slight increase in arsenic through 1997, primarily during the time-period that the S-X stream was diverted to the scrubber pond. Well KM-2 spiked in 1994 and has decreased since that time. Well KM-4 spiked in 1994 and again during 1997. Concentration spikes may have been related to discharge of the S-X stream to the scrubber pond. Arsenic concentrations have generally been decreasing near the former scrubber pond since LSE and reclamation in 1997, with a flattening of the trend since 1999.

Wells near the west side of the facility or near the former S-X pond indicate an arsenic concentration decrease with time through 1995. Except for well KM-8, all wells are below the RBC. Well KM-8 currently exceeds the RBC and indicated an increasing trend between May 1995 when the pond was taken out of service and 2002. The cause for the increase in arsenic concentrations since closure of the S-X pond is unknown. Concentrations of arsenic have decreased slightly since 2002.

Manganese

Wells located near the former scrubber pond show variable manganese concentrations throughout operation and then small decreases to the present. Increases in the concentrations of manganese during earlier time periods are attributed to S-X stream discharge into the scrubber pond. Wells KM-3 and KM-4 show significant variability between sample rounds through 1997. KM-4 manganese concentrations spiked during 1994 and decreased through the present. Manganese concentrations in well KM-3 spiked during 1997 then decreased with time though 2000. Recently, the manganese trend has flattened at levels below the RBC. Well KM-3 is the only well in this group that currently exceeds the RBC for manganese, and shows increasing concentrations following November 2000 through May 2005.

Wells near the west side of the facility or near the former S-X pond indicated a decrease in manganese with time between 1995 and 2000. Trends for manganese have flattened from 2000 to the present. Well KM-6 indicates considerable variability with time that suggests seasonal trends, although this was less notable between 2002 and 2004. KM-7 has comparable concentrations and trends to KM-6, although KM-6 experienced a concentration rise in 2005 that was not seen in KM-7. Well KM-19 is about at background concentration. Well KM-8 also exceeds the RBC for manganese. The trend indicated a decrease through 1994, and increasing concentrations through 1997. Concentrations of manganese have fluctuated, but generally began to decrease several years following LSE and reclamation efforts in 1997.

Molybdenum

Molybdenum concentration trends for wells located near the former pond facilities are contained in Appendix A. Molybdenum trends with time are comparable to sulfate trends. Wells located near the former scrubber pond indicated decreasing molybdenum concentrations with time following LSE and reclamation through 2000. Wells KM-2, and KM-11 have all indicated slightly decreasing molybdenum concentrations following 2000 to the present. Wells KM-3 and KM-4 molybdenum concentrations remained steady or showed slight increases through 2004 and decreased in 2005. Molybdenum concentrations in well KM-3 spiked in 1997 during the remediation and stabilization of the scrubber pond solids.

Wells KM-5, KM-9, KM-12, KM-13, and KM-19 near the west side of the facility or near the reclaimed S-X pond indicate a concentration decrease with time through 2000, with nearly flat trends to the present. KM-6 indicates an overall decreasing trend through 2004, and that seasonal increasing/decreasing trends may account for some of the variability between rounds. Increased concentrations occur during periods of higher water level elevation (spring sampling) in this well.

Well KM-8 molybdenum concentrations peaked during late 1994. Well KM-8 indicates substantial concentration variability with time similar to the common ion trends, but an overall decreasing trend with time following LSE and reclamation events. Trends have been slowly decreasing with little seasonal variation since 2000. Molybdenum concentrations spiked in KM-8 in the spring of 2005.

Vanadium

Vanadium trends in wells located near the former pond facilities are contained in Appendix A. Shallow wells located near the reclaimed scrubber pond indicate decreasing vanadium concentrations with time following LSE in 1997. Well KM-11 is an order of magnitude below the RBC, and indicates little change since 1997. KM-3 indicates a flattening of the vanadium concentration between May 1998 and May 2001, and a steady or slightly rising trend following capping of the calcine. Well KM-4 vanadium concentrations increased substantially through 1997 and decreased with time through early 2000. Well KM-2 vanadium concentrations increased through 1996 as the result of the S-X discharge to the scrubber pond, and decreased substantially in 1997 when the pond was reclaimed and the calcine pond dried. Vanadium concentrations again increased between 1997 and May 2000 following LSE, and began to decrease slightly to the present.

Wells KM-5, KM-8, KM-9, KM-12, KM-13, and KM-19 located near the west side of the facility or near the reclaimed S-X pond indicate a concentration decrease with time through 2000 or 2001. This decreasing trend flattened somewhat through 2003. Wells

KM-6 and KM-7 have larger ground water vanadium concentrations than other wells in this group (except KM-8). Well KM-6 indicates that seasonal increasing/decreasing trends may account for some of the variability between rounds. Increased concentrations occur during periods of higher water level elevation in this well. Well KM-6 continues to indicate vanadium concentrations within the range of historic values, but indicates a generally decreasing trend following LSE.

Well KM-8 vanadium concentrations began to decrease in KM-8 beginning in 1992 and continue to decrease following LSE in 1997. In May 1998, vanadium concentrations began to increase in KM-8 with an increasing trend through 2004. Concentrations decreased in 2005. While low pH in the well has explained an increase in concentrations in this well, the increase between 1998 and the present is not known.

5.2.3 Organics

Total Petroleum Hydrocarbons

TPH concentrations were less than detection in all wells with the exception of KM-8 during 2003. TPH was analyzed in POC wells between 1997 and 1999, and again during May 2002 to assess concentrations for the EPA 5-year site review.

KM-8 is the only POC well routinely sampled for TPH. TPH concentrations with time for well KM-8 are contained in Appendix A. Concentrations of TPH decreased with time in well KM-8 to less than detection in 1999 using analytical Method 418.1. During 2000 and 2001, TPH concentrations using Method SW846 8015B appear to have increased above historic ranges. Concentrations have decreased since 2000 to current levels of about 1.1 mg/l.

5.2.4 Conclusions of On-Site Well Concentration Trends

Conclusions drawn from the review of on-site well concentration trends include:

- Nearly all on-site wells exceed the RBC of molybdenum and vanadium. Nearly all wells demonstrate decreases in concentration with time, although the decreasing trend for some general indicators and metals has become less since 2003.

- Concentrations of common ions have generally decreased through 2005 in almost all POC wells following LSE and surface reclamation.

- Concentrations of manganese declined following LSE and reclamation to less than the RBC in all on-site wells with the exception of KM-3 and KM-8.

- Several shallow wells indicate seasonal variability in concentration or changes in concentration in correspondence with water levels. For some wells, including KM-6 and KM-8, this seasonal trend diminished between 2002 and 2004, although concentrations continue to generally decrease.

- TPH continues to slightly exceed the RBC in KM-8, although trends indicate a decline in concentration that is quickly approaching the RBC.

- TBP is currently detected in KM-8, although this TIC was not noted between 1998 and 2001. TBP is also continuing a trend of declining concentration.

- Arsenic exceeds the current RBC of 50 ug/l in well KM-8. Arsenic appears to be generally increasing with time since pond reclamation through 2003, with a decreasing trend between 2003 and 2005. All other POC wells are less than detection or less than the 50 ug/l RBC for arsenic. Arsenic remains above detection and the revised arsenic MCL in three shallow ground water wells near the reclaimed scrubber pond.

- Well KM-8 indicates vanadium concentration increases between 1998 and 2004. Recent vanadium concentrations are within or greater than the concentration ranges observed during pond operation.

5.3 Off-Site Well Concentration Trends

The following sections provide a discussion of concentration trends with time for the off-site wells (KMC LLC wells located beyond the POC), located to the south on the property previously owned by Larry Hopkins, but purchased by KMC LLC in 2004. Off-site wells that are now on KMC LLC property include KM-15, KM-16, KM-17, and KM-18. Changes in concentration with time are generally smaller in the off-site wells as a function of their greater distance from the site and pond areas that impacted ground water quality.

However, many decreases in concentrations are noted following the implementation of various LSE activities at the site.

In general, concentrations and concentration trends observed in paired shallow and intermediate wells KM-15 and KM-18 are nearly identical for a number of chemicals. Concentrations decreased steadily since the time of the remediation of the MAP ponds in 1993. Wells KM-15 and KM-18 appear to be more directly affected by activities on the west side of the plant facility. Well KM-16 indicates seasonal fluctuations and demonstrates more of a delayed response to LSE and pond basin remediation performed between 1995 and 1997. Well KM-17 has been impacted by operations that occurred in the vicinity of the former scrubber pond. Well KM-17 has large concentrations of common ions, but appears minimally impacted by arsenic, manganese, and vanadium.

5.3.1 Common Ions and General Indicators

Based on a review of concentrations versus time for these three parameters, the following general observations are described below. Graphs of concentrations versus time are contained in Appendix A.

pH

Off-site indicate a similar trend to on-site wells, with a general decrease in pH noted in late 1999 through 2001 from previous neutral to slightly alkaline conditions. The pH in the ground water was slightly less than neutral in 2005 in wells KM-15, KM-16 and KM-18.

TDS

Paired wells KM-15 and KM-18 have similar TDS concentrations, and show an overall decrease in concentration with time through 2003 with slight rises to 2005. Well KM-16 indicates a decreasing trend with time following LSE. Seasonal trends may account for some of the variability between rounds; however, this is less notable following 2000. Increased concentrations occur during periods of higher water level elevation in this well. Well KM-17 has the largest of the off-site well TDS concentrations. All wells show slight rises in TDS concentrations between 2004 and 2005.

Chloride

Wells KM-15 and KM-18 indicate matching concentrations, and show an overall decrease with time through 2000. The trend has become flat between 2003 and 2005, although small decreases are consistently noted. Wells KM-16 and KM-17 indicate a more direct response to LSE than wells KM-15 and KM-18, which indicated an earlier decrease in chloride. KM-16 indicates a larger decrease following 1999. Well KM-17 chloride concentrations are the largest identified in the off-site wells. This well has been affected by lateral dispersion from the scrubber pond, and indicates variably decreasing concentrations since pond reclamation in 1997.

Sulfate

Wells KM-15 and KM-18 indicate nearly identical concentrations, and show an overall decrease with time since initial sampling in 1992. This trend flattened between 2000 and the present. Well KM-16 and KM-17 sulfate concentration trends appear to be decreasing following LSE and scrubber pond reclamation efforts in 1997.

Nitrate plus Nitrite

Concentrations of nitrite plus nitrate decreased following LSE in the off-site wells. Well KM-15 nitrate plus nitrate concentrations spiked during May 1993, then decreased through 2001. Well KM-18 nitrate plus nitrate concentrations spiked during May 1994, then decreased to the recent KM-15 concentration. Well KM-16 indicates a decreasing trend with time, and seasonal increasing/decreasing trends. Concentrations of nitrite plus nitrate increase during periods of higher water level elevations in this well, although this has become less notable since 2000. Well KM-17 demonstrates the smallest variability with time, but indicates an overall decreasing trend. Wells KM-15and KM-16 demonstrate small rising trends since 2001.

5.3.2 Off-Site Metal Concentration Trends

Graphs of metal concentrations versus time include the group of metals identified by EPA as COC. COC metals versus time are presented in Appendix A and described in the following sections.

Arsenic

All off-site wells are well below the detection limit and the RBC for arsenic. Off-site wells are less than the detection limit of 10 ug/l.

Manganese

Off-site wells are below the RBC for manganese. Concentrations of manganese in well KM-15, KM-16, and KM-18 decreased with time from initial concentrations that were greater than the RBC. Well KM-17 manganese concentrations remain low, near the detection limit. Well KM-16 indicates an overall even but slightly decreasing trend with time and seasonal trends between rounds. This trend is less notable since 2000. Increased concentrations occur during spring sampling rounds. Decreases in manganese concentrations in KM-16 show a lag time behind the other off-site wells, but concentrations appear to be decreasing more rapidly since LSE and reclamation completed by the end of 1997.

Molybdenum

Concentrations of molybdenum in wells KM-15 and KM-18 peaked prior to 1995 during pond operation and began to decline after diversion of the S-X stream to the double-lined ponds. Both wells have similar concentration trends and both indicate significant concentration decreases with time through 2000. The trend has flattened somewhat between 2000 and the present, although concentrations continue to decline with time. Well KM-16 indicated a steady molybdenum concentration with time through 1997. Molybdenum concentrations decreased in May 1998, approximately six months following LSE and pond reclamation. Well KM-16 indicated seasonal increasing/decreasing trends through 2001. Increased concentrations occurred in the spring during periods of higher water level elevation. KM-17 molybdenum concentrations increased slightly from 1998 through 2004. KM-17 is currently at a slightly larger concentration than wells KM-15 and KM-18. All off-site wells exceed the RBC of 180 ug/l.

Vanadium

Concentrations of vanadium in wells KM-15 and KM-18 peaked prior to 1993 and began to decline after diversion of the S-X stream to the scrubber pond and elimination of the MAP ponds. Both wells have parallel decreasing concentration trends, with well KM-18 having a consistently lower concentration. Both wells indicate considerable concentration decreases with time through 2000. Well KM-16 has the largest vanadium concentration of all off-site wells. Recent concentrations in KM-16 are below the 1992 levels and indicate a decreasing trend following LSE. Off-site wells exceed the RBC for vanadium with the exception of well KM-17, which has relatively unchanged concentrations since November 1997. Well KM-17 vanadium concentrations slowly increased with time through July 1997, and then decreased by November 1997 to recent concentration levels. Vanadium increases in KM-17 were attributed to dispersion of seepage from the former scrubber pond that was receiving the S-X stream prior to closing the pond.

5.3.3 Organics

Organics are no longer sampled in the off-site wells. TPH was last sampled during November 1996. Concentrations of TPH remained relatively unchanged with time.

Concentrations of TPH during 1996 were reported at the detection limit. TBP concentrations increased through May 1994 in the off-site wells, and then decreased to less than the RBC in October 1995. TBP in well KM-16 was not detected after May 1993.

5.3.4 Conclusions of Off-Site Well Concentration Trends

Conclusions drawn from the review of off-site well concentration trends include:

- Off-site wells exceed the RBC for molybdenum and vanadium (except KM-17 for vanadium), but are below the RBC for arsenic, manganese, and assumed to be below the RBC for organics. Well KM-16 returned to an exceedence of the manganese RBC in 2005. Concentrations are indicated to decrease with time following LSE, with the exception of molybdenum concentrations which continued to rise in KM-17 through 2004.

- Concentrations of common ions, TDS, and metals continue to generally decrease with time following LSE and reclamation. Well KM-17 continues to indicate increased chloride, sulfate, TDS and molybdenum following 1997. Concentrations in well KM-17 were affected by dispersion of seepage from the facility following LSE and reclamation. Current concentration trends in KM-17 may be related to changes in flow direction following capping of the calcine.

- Concentrations of common ions, TDS, and metals in ground water show smaller changes with time in well KM-16. A general decrease in concentrations is noted approximately six months following LSE and pond basin reclamation. Well KM-16 indicates an overall decreasing trend with time since 1998, and seasonal trends through 2000.

5.4 Off-Site Surface Water Quality Concentration Trends

KMC LLC routinely monitors surface water quality at four spring locations that include Finch Spring, Big Spring, and Upper and Lower Ledger Springs. Finch Spring originates from the base of the Finch Spring Fault scarp, approximately 4000 feet to the south of the KMC LLC facility. The spring has been routinely sampled since 1991. Big Spring emerges at the south end of the valley floor, just to the north of the Bear River, and was first sampled by KMC LLC in 1993. This spring is located approximately 4 miles south of the facility and south of the town of Soda Springs. Flow from this spring is considerably greater than Finch Spring, although this flow was smaller between 2001 and 2004 due to several years of below normal precipitation. Big Spring flows into Hatchery Creek and then into the Bear River. Parameters analyzed from these springs include general indicator parameters, common ions, and metals. Parameter concentrations versus time for these locations are presented in the graphs in Appendix A.

During June 2000, EPA requested KMC LLC resume routine sampling of Upper and Lower Ledger Springs. These springs were first sampled by KMC LLC in 1991, and are located approximately 1.5 miles south of the plant. These springs are a source of drinking water for Soda Springs. Sample results indicate that no impacts are present or that metals are substantially below the RBC when detected. No graphs are presented for Upper and Lower Ledger Springs because chemical concentrations evaluated in this report are typically less than detection for metals parameters. well . Data obtained by KMC LLC from Ledger Springs are analyzed with time using ratios of common ions in a Piper analysis. This analysis is a tool used to evaluate mixing of different water types.

5.4.1 Common Ions and General Indicators

Common ion ratios for off-site springs are plotted on the Piper diagrams shown on Figures 5-1 through 5-4. These diagrams show common ion ratio trends for springs sampled during the years 1991 and 2000 through 2005 (refer to sections 4.1 and 4.2 for discussion of background and Piper diagrams). The ratio of common ions shown on Figure 5-1 for the Upper and Lower Ledger Springs indicates little sulfate and chloride, with indications of mixing with waters affected by the KMC LLC facility. Also, little change is noted with time, since the samples plot in the same location over time. These springs plot within the range of background water quality for the basalt aquifer (Dames & Moore, 1995). The Ledger Springs are predominantly bicarbonate composition.

Figure 5-2 shows that Big Spring is reducing in relative percent to sulfate and chloride and increasing in bicarbonate with time (1993 to 2003) in the direction toward plotted locations of background water quality. Plots of sampled events shown on Figure 5-2 indicate that water chemistry general composition has changed between sample events at Big Springs. Figure 5-3 shows that Finch Spring is reducing in chloride with time, although the relative percent change has slowed since 2000. The mixing trends for Big and Finch Springs with time indicates a trend towards sulfate and chloride. This mixing is apparent on Figure 5-4, which shows plots of all of the sampled locations relative to background, with background represented by Ledger Springs. Finch Spring is slightly more dominated by chloride (scrubber stream trend) and Big Spring is dominated by sulfate (S-X stream trend, Dames & Moore, 1995).

TDS

TDS concentrations at Finch Spring increased through October 1994 as the result of pond operation at the site and changes in the discharge of the S-X stream. TDS concentrations decreased following 1995 to the present concentration of 560 mg/l. Concentrations have been steady since 2003.

Concentrations of TDS at Big Spring decreased consistently since 1996 to current levels that are comparable to Finch Spring. Big Spring is located at the most downgradient discharge point in the valley. Big Spring has larger TDS concentrations than Finch Spring. Elevated, concentrations of TDS at Big Spring may be related to other upgradient sources other than the KMC LLC facility. Small seasonal trends are noted in the Big Spring TDS data.

The Ledger Springs TDS concentrations were 630 mg/l in May 2005. TDS concentrations at the Ledger Springs are less than the concentrations at Big and Finch Spring, and represent background.

Chloride

Concentrations of chloride at Finch Spring increased through October 1994, peaked again in late 1996, and then decreased in concentration through May 2005 below 1991 levels when sampling was initiated. Concentrations leveled off in 1999 but then continued a decrease through the present. Chloride is a conservative tracer because transport in ground water is generally through the hydrodynamic process, traveling essentially at the same rate as ground water flow. Therefore, changes in chloride concentrations at Finch Spring reflect process and remedial changes at the plant.

Chloride concentrations decreased in Big Spring after 1996. These trends may reflect, in part, some of the earlier LSE changes made at the plant. However, Big Spring is located at the most downgradient discharge point in the valley, and decreasing concentrations of chloride may be related to factors affecting water quality not related to the KMC LLC facility. This trend flattened somewhat in 2000. The chloride concentrations at Ledger Springs are lower than chloride concentrations at Big and Finch Springs, and ranged from 4.4 to 4.6 mg/l in May 2005.

Sulfate

Sulfate trends at Finch Spring are remarkably similar to the chloride trends. Sulfate peaked in October 1994 and 1996 and decreased to the present concentrations. Changes in sulfate concentrations in Finch Spring are related to former S-X stream discharges to the scrubber pond. Concentrations of sulfate at Finch Spring decreased in 2005 to within or below the range of 1991 concentrations. Sulfate concentrations at Big Spring also indicate steady decreases with time through 2005, although this rate of change has become less since 2001. The Ledger Springs sulfate concentrations are also lower than Big and Finch Springs, about 32 mg/l in 2005.

Nitrate plus Nitrite

Nitrate plus nitrite concentrations are similar at Finch and Big Springs locations. Both locations suggest slight seasonal trends in the data, with larger concentrations occurring in the fall season and at Big Springs. Both locations indicate generally decreasing concentration trends with time through 2005, although the trend has flattened at Finch Spring in 1999 and at Big Spring in 2001. The Ledger Springs nitrate plus nitrite concentrations are an order of magnitude lower than concentrations at Big and Finch Springs, and ranged from about 0.41 to 0.46 mg/l in May 2005.

5.4.2 Metals Concentration Trends

Graphs of metals versus time are presented in Appendix A and described in the following sections.

Arsenic

Arsenic concentrations are less than the reporting limit at all spring locations during 2003.

Manganese

Concentrations of manganese are generally less than, or near the reporting limit at Finch Spring. Concentrations of manganese are less than detection at all remaining sampled spring locations in May 2005.

Molybdenum

Concentrations of molybdenum at Finch Spring indicate decreasing trends through 1996. The concentration then increased sharply and peaked in July 1997. Concentrations of molybdenum generally decreased between 1997 and the 2005.

Historic increases and decreases in molybdenum concentrations for Finch Spring were related to changes in the discharge locations of the S-X stream.

Molybdenum concentrations increased at Big Spring through 1997 then decreased through 2000. Concentrations of molybdenum increased slightly in 2001, as noted at Finch Spring. The trend for molybdenum flattened in 2003 although an overall decreasing trend is noted. These trends may reflect, in part, some of the earlier LSE changes made at the plant. However, Big Spring is located at the most downgradient discharge point in the valley, and continued elevated molybdenum concentrations at Big Spring may be related to factors affecting water quality not related to the KMC LLC facility.

Molybdenum was estimated as detected at 2.8 ug/l in Upper Ledger Springs in May 2005, but less than detection at Lower Ledger Spring.

Vanadium

Vanadium concentrations increased at Finch Spring through 2001. Concentrations of vanadium peaked at Finch Spring in 2001, and decreased to 61 ug/l in 2005. Increases in vanadium concentrations at Finch Spring are believed to be the result of operational S-X stream discharges to the scrubber pond. Vanadium concentrations at Big Spring were below the detection limit but estimated at 2.5 ug/l. Vanadium was not detected at Ledger Springs in May 2005.

6.0 PROJECTED CONCENTRATION DECAY TRENDS

This section presents an analysis using existing ground water monitoring data to project future concentrations, and when these concentrations may potentially fall below their respective RBC for manganese, molybdenum, or vanadium. Arsenic, TBP, and TPH are less than the RBC for all wells except KM-8, and therefore are not considered in this analysis.

Projected concentration decay trends are estimated where possible, using a regression trend curve fitted to the real-time monitoring data from wells where the COC currently exceed the risk-based concentration. Only wells exhibiting a decreasing concentration following LSE are considered in the analysis for the projection of future concentrations. This group includes wells on-site wells KM-2, KM-3, KM-5, KM-6, KM-8, KM-9, KM-12 and KM-13; and off-site wells KM-15, KM-16 and KM-18. Results of the analysis are summarized in Table 6-1. Decreasing molybdenum and vanadium trends were less evident in ground water on the east side of the site.

COC concentration trends with time and projected trends for these wells are presented in Appendix B. The time-period selected for each well location varies slightly, and was based on LSE in a nearby pond basin, or reclamation of a pond basin (annotated on the graphs). Projected trends are based on the post-LSE monitoring period data. The projected period is through the year 2015. This year was selected based on a time length of approximately 20 years after the S-X stream was contained within lined ponds.

6.1 Analytical Method

Existing ground water data were evaluated using a statistical forecast function for exponential decay. A forecast calculates or predicts a future value by using existing values. The predicted value is a y-value (future concentration of a COC in ground water) for a given future date. The known values are ground water data from the wells. A forecast statistically predicts future values based on a regression function of a range of known data or known x- and y-arrays. Regression analysis estimates the relationship between variables, so that a given variable can be predicted from one or more other variables.

Data curves for the ground water concentrations were generated using an exponential function that describes decay of a substance and calculates the least squares fit through points by using the equation:

$$y = ce^{-kt}$$

where:

e is the base of the natural logarithm;

c is a constant at y_0 (initial concentration) at $t = 0$, and;

$-kt$ is a constant for the predicted time, with the minus sign representing decay of concentration with time.

A trendline is generated for the data based on known x-values for the best-fit curve. The y intercept for the regression trendline is set at zero. This is appropriate, based on the observed absence of manganese, molybdenum and vanadium in background ground water quality data.

6.2 Results of Trendline Analysis

Results of the trendline analysis are presented on the graphs in Appendix B. It is possible that future ground water concentration trends may differ from results generated using real-time data. A number of factors can potentially affect future ground water concentrations and trends. These factors may include, among others, changes in ground water pH, significant changes in precipitation, infiltration and site runoff, capping of the calcine, and significant changes in ground water levels.

The minimum range of each graph has been set at the respective RBC where the 2005 ground water concentration exceeds the RBC. Analysis of the forecast trends suggests the following:

- Wells KM-5 and KM-9 were reduced to the RBC for Molybdenum in 2003 as predicted by use of these trendlines. However, recent results indicate a recurring exceedence following increased precipitation events in May 2005.

- Analysis of 2005 data indicates that in most cases, molybdenum and vanadium concentration decreases lag predictions made in 2004 for wells KM-6, KM-8, KM-12, KM-13, KM-16, and KM-18, largely resulting from flattening of vanadium and molybdenum trends between 2003 and 2005.

- Molybdenum concentrations will continue to decline in most wells in response to LSE and reclamation. Wells KM-12, KM-13, KM-15, and KM-18 are projected to fall below the RBC before 2012. Wells KM-2, KM-3, KM-6 and KM-8 are estimated to fall below the RBC beyond 2015 based on current trends. Off site well KM-17shows no clear trend in molybdenum reductions.

- With the exception of wells KM-9 and KM-13, most on-site wells and several off-site wells are forecast to exceed the vanadium RBC for a period of ten years or greater, following completion of LSE in 1997 and pond reclamation. Wells KM-9 and KM-13 are the first wells expected to drop below the RBC for vanadium, which is not expected to occur prior to 2010.

- Manganese is estimated to potentially exceed the RBC in POC well KM-8 for greater than 15 years following LSE. The rising manganese trend in well KM-3 following 2000 is anomalous to other wells in the vicinity of the covered scrubber pond.

7.0 CONCLUSIONS

During 1997, KMC LLC discontinued discharges from unlined ponds to ground water. Analysis of real-time monitoring data indicates that remediation efforts of the ponds prior to and during 1997 resulted in notable ground water quality improvement at most of the on-site, POC, and off-site well locations. Predicted trends (water quality projections based on real-time monitoring) suggest that a number of KMC LLC well locations have the potential to drop below the RBC for vanadium and molybdenum within 10 to 15 years following LSE. Other wells, including those near the reclaimed scrubber pond and off-site well KM-17 indicate no clear trend.

Based on a review of water quality through May 2005, recent water quality trends, and predictions of future concentrations, the following conclusions are drawn.

On-site Water Quality Conclusions

- Generally, concentrations of common ions and TDS have decreased with time in the on-site wells. This trend has flattened somewhat between 2000 and the present for a number of the on-site wells near the west side of the facility as these concentrations approach background. Seasonal trends noted in some well locations, including KM-6 and KM-8 appear to be related to changes in water levels or seasonal infiltration. These seasonal effects are less discernable between 2001 and 2004, but are again noted in 2005 with increases noted in a few wells. A small rising nitrate trend is noted at several well locations between 2001 and 2005.

- Vanadium and molybdenum continue to exceed the RBC at most of the on-site POC wells and non-POC wells. Wells KM-5 and KM-9 fell below the molybdenum RBC in 2003, but were above the RBC in 2005. Molybdenum and vanadium concentrations are generally decreasing with time in nearly all wells.

- A decreased pH in the ground water between 1999 through 2001 may have caused increased concentrations in some POC wells. The pH is now near-neutral across the site and at off-site locations.

- Concentrations of TBP and TPH slightly exceed the RBCs in well KM-8 ground water. TPH indicates a decreasing ground water trend between 2000 and the present. TBP indicates an overall decreasing trend since LSE was implemented in 1997.

- Arsenic is less than detection at most on-site well locations and was identified at small concentration in shallow ground water near the reclaimed scrubber pond. Concentrations of arsenic continue to exceed the 50 ug/l RBC in well KM-8. Arsenic concentrations increased between May 1995 and 2002 in the ground water monitored by KM-8, and declined to present levels. Arsenic is less than detection at off-site well locations.

- Manganese concentrations decreased with time in nearly all wells following LSE actions performed in 1997, and concentrations are below the RBC in nearly all POC wells. Well KM-3 indicates an increasing manganese trend following implementation of LSE. Manganese exceeds the RBC in two POC wells. Well KM-8 manganese concentrations are seasonal and decreased substantially since 1997, but currently remain an order of magnitude above the RBC.

- On-site deep well KM-19 was below the RBC for all COC in 2005.

- Predicted water quality for many of the POC wells suggest that molybdenum and vanadium concentrations will exceed the RBC for 10 or more years following LSE.

Off-Site Ground and Surface Water Quality Conclusions

- Generally, common ions and TDS decreased with time in the off-site wells, but appear to flatten somewhat in 2003.

- Concentrations of common ions and TDS decreased in well KM-17 since peaking in 1998. There is not a clear molybdenum trend in this well as it remains above the RBC and within the historic range of concentration.

- Vanadium and molybdenum continue to exceed the RBC at most of the off-site wells. Molybdenum and vanadium concentrations are variable, but continue to decrease with time.

- Arsenic and manganese are less than detection and the RBC, respectively, at all off-site well locations. Manganese continues to decrease at off-site locations.

- Finch and Big Spring exceed the RBC for molybdenum only. Both locations continue to indicate decreasing trends

- Vanadium concentrations at Finch Spring increased between May 1993 through October 2003, with a peak concentration occurring in October 2001. Concentrations of vanadium have decreased since that time. Increased vanadium concentrations in Finch Spring occurred as the result of previous operational S-X stream discharges to the reclaimed scrubber pond located on the east side of the facility. Vanadium concentrations in Finch Spring are less than the RBC, and vanadium is less than the reporting limit in Big Spring.

- Piper analyses indicate that the Ledger Springs continue to show no mixing effects from KMC LLC pond water. Trace concentrations of molybdenum were reported in May 2005 at Upper Ledger.

COC Trendline Predictions

- In some cases, vanadium trendlines based on 2003 data appear to lag behind previous evaluations. However, KM-5 and KM-9 met the molybdenum RBC as predicted in 2003. Wells KM-5 and KM-9 but were above the RBC in 2005.

- Molybdenum is projected to be less than the RBC in three of the downgradient POC wells within ten years following LSE. Molybdenum concentrations will continue to exceed the RBC at for the remaining on-site wells for considerably longer.

- The concentration of vanadium is projected exceed the RBC in most on-site POC wells and off-site wells for fifteen years or more following 1997 LSE actions, with the exception of KM-19 which is already below the RBC. Wells KM-9 and KM-13 are predicted to be near the RBC within about ten years following LSE.

- As a result of overall larger concentrations and unclear trends for arsenic and vanadium concentrations, well KM-8 continues to lag other wells in concentration decreases. Therefore, KM-8 will take considerably longer to fall below the RBCs for manganese, molybdenum and vanadium.

8.0 RECOMMENDATIONS

Ground and surface water monitoring will continue at the KMC LLC facility on a semiannual basis to assess the effects of remedial changes made at the site as required in the ROD. Parameters that fall below the RBC will be evaluated and reported to EPA when these occur. All sampling and analytical results should be reviewed semiannually in accordance with the protocols contained in SW846 and EPA laboratory data validation functional guidelines to assess the quality of the data results. Ground and surface water quality will be appended semiannually to the RD/RA database. Results of the data review will be transmitted to EPA. All ground water quality trends and predicted quality should be evaluated in an annual report to assess the improvements to ground and surface water quality. Field data results should be evaluated to assess current with preceding site conditions.

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TABLE 1-1
MONITOR WELL CONSTRUCTION DATA

Well Designation	Well Completion Date	Drilled Total Depth (T.D.) Below Grade (ft)	Boring Diameter (inches)	Steel Casing Depth Below Grade (ft)	PVC Casing Depth Below Grade (ft)	Screen Depth Below Grade (ft)	Sand Pack Interval Below Grade (ft)	Bentonite Interval Below Grade (ft)	Grout Seal Depth Below Grade (ft)
KM-1	10-07-91	56.5	8" 0 to T.D.	0 to 6.5	0 to 45.9	45.9 to 55.9	44.5 to 56.5	39.4 to 44.5	0 to 39.4
KM-2	09-21-91	57.8	8" 0 to T.D.	0 to 37.6	0 to 47.2	47.2 to 57.2	44.7 to 57.8	40.7 to 44.7	0 to 40.7
KM-3	10-11-91	49.5	8" 0 to T.D.	0 to 6.0	0 to 39.1	39.1 to 49.1	36.7 to 49.5	30.5 to 36.7	0 to 30.5
KM-4	10-02-91	54.5	8" 0 to T.D.	0 to 12.1	0 to 43.7	43.7 to 53.7	41.6 to 54.5	36.7 to 41.6	0 to 36.7
KM-5	10-01-91	49.3	8" 0 to T.D.	0 to 3.8	0 to 38.0	38.0 to 48.0	35.9 to 49.3	31.9 to 35.9	0 to 31.9
KM-6	09-24-91	45.3	8" 0 to T.D.	0 to 11.9	0 to 34.7	34.7 to 44.7	31.2 to 45.3	26.4 to 31.2	0 to 26.4
KM-7	09-26-91	56.8	8" 0 to T.D.	0 to 19.6	0 to 46.2	46.2 to 56.2	44.3 to 56.8	39.6 to 44.3	0 to 39.6
KM-8	10-21-91	46.0	8" 0 to T.D.	0 to 10.8	0 to 34.6	34.6 to 44.6	32.4 to 46.0	27.8 to 32.4	0 to 27.8
KM-9	09-29-91	58.3	8" 0 to T.D.	0 to 21.0	0 to 47.5	47.5 to 57.5	45.5 to 58.3	39.3 to 45.5	0 to 39.3
KM-10	10-12-91	121.0	10" 0 to 67 ft 8" 67 to T.D.	0 to 57.0	0 to 100.0	100.0 to 120.0	93.6 to 121.0	88.4 to 93.6	0 to 88.4
KM-11	10-29-91	105.0	10" 0 to T.D.	0 to 18.7	0 to 80.0	80.0 to 100.0	78 to 105.0	73 to 78	0 to 73
KM-12	10-29-91	155.0	8" 0 to T.D.	0 to 7.1	0 to 134.1	134.1 to 154.1	127 to 155.0	121 to 127	0 to 121
KM-13	10-07-91	57.0	8" 0 to T.D.	0 to 22.5	0 to 46.4	46.4 to 56.4	44.3 to 57.0	37.6 to 44.3	0 to 37.6
KM-15	09-24-92	58	10" 0 to T.D.	0 to 5.0	0 to 45.2	45.2 to 55.2	42.8 to 57.0	36.5 to 42.8	0 to 36.5

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TABLE 1-1
MONITOR WELL CONSTRUCTION DATA

Well Designation	Well Completion Date	Drilled Total Depth (T.D.) Below Grade (ft)	Boring Diameter (inches)	Steel Casing Depth Below Grade (ft)	PVC Casing Depth Below Grade (ft)	Screen Depth Below Grade (ft)	Sand Pack Interval Below Grade (ft)	Bentonite Interval Below Grade (ft)	Grout Seal Depth Below Grade (ft)
KM-16	09-18-92	74.6	10" 0 to 5 ft 8" 5 to T.D.	0 to 5.0	0 to 63.3	63.3 to 73.3	60.8 to 74.6	56.0 to 60.8	0 to 56.0
KM-17	09-25-92	49.1	10" 0 to 5 ft 8" 5 to T.D.	0 to 5.0	0 to 38.2	38.2 to 48.2	36.3 to 49.1	30.9 to 36.3	0 to 30.9
KM-18	10-03-92	180	10" 0 to T.D.	0 to 5.0	0 to 152.6	152.6 to 172.6	150 to 173	145 to 150	0 to 145
KM-19	10-15-92	218	12" 0 to 8 ft 10" 8 to 167 ft 8" 167 to T.D.	0 to 57	0 to 193.6	193.6 to 213.6	190.9 to 214	182.9 to 190.9	0 to 182.9
MW-1	6-63	51.3	NA	NA	NA	NA	NA	NA	NA
MW-2*	6-63	42.4	NA	NA	NA	NA	NA	NA	NA
MW-3*	6-63	42.5	NA	NA	NA	NA	NA	NA	NA
MW-4	6-69	47	NA	NA	NA	37-47	20-47	NA	NA
MW-5	12-72	65	NA	NA	NA	NA	NA	NA	NA
MW-6	12-72	55.2	NA	NA	NA	NA	NA	NA	NA
MW-7	12-72	58	NA	NA	NA	48-58	20-58	NA	NA
MW-8	9-81	76	NA	NA	NA	26-76	20-76	NA	NA
MW-9	9-81	68	NA	NA	NA	28-68	17.5-68	NA	NA

* Well abandoned during Phase I.
NA Not Available

14626-019-031

TABLE 1-2
MAXIMUM CONCENTRATIONS OF COC AND MOST CURRENT CONCENTRATIONS IN KMC LLC WELLS AND OFF-SITE SPRINGS

Well Designation	Arsenic Concentrations		Manganese Concentrations		Molybdenum Concentrations		Total Petroleum Hydrocarbons Concentrations		Tributyl Phosphate Concentrations		Vanadium Concentrations	
	RBC = 50 ug/l		RBC = 180 ug/l		RBC = 180 ug/l		RBC = 0.73 mg/l		RBC = 180 ug/l		RBC = 260 ug/l	
	Largest (ug/l)	Most Current (ug/l)	Largest (ug/l)	Most Current (ug/l)	Largest (ug/l)	Most Current (ug/l)	Largest (mg/l)	Most Current (mg/l)	Largest (ug/l)	Most Current (ug/l)	Largest (ug/l)	Most Current (ug/l)
KM-2*	53	12	444	55	11800	1300	2.0	NA	7	NA	15500	4200
KM-3*	27	17	1680	530	44900	7700	1.8	NA	1400	NA	13200	5200
KM-4	63	9.4	1160	100	15300	2700	NA	NA	NA	NA	23300	4200
KM-5*	12.2	3.4	399	3.5	1460	190	NA	NA	3	NA	15800	1300
KM-6	6.5	5.7	291	210	2140	1400	2.0	NA	110	NA	6630	3800
KM-7	6.9	6.9	197	110	593	430	2.0	NA	NA	NA	3410	2400
KM-8*	170	82	8770	3000	165000	49000	9.5	1.1	4442	240	29000	17000
KM-9*	5	ND	113	6.7	1740	210	NA	NA	ND	NA	3590	450
KM-11*	2	ND	157	19	5600	390	0.42	NA	112	NA	492	10
KM-12*	23	ND	177	30	9290	590	0.39	NA	13	NA	5580	750
KM-13*	4	ND	131	13	6790	320	0.18	NA	12	NA	6420	510
KM-15	5.6	ND	543	68	6950	490	0.15	NA	484	NA	3840	930
KM-16	7.3	4.5	364	120	2300	840	1.9	NA	180	NA	4250	2200
KM-17	1.5	ND	84	4.2	987	510	1.2	NA	170	NA	493	4.3
KM-18	3.7	ND	332	51	6340	460	1.3	NA	410	NA	2990	720
KM-19*	2	ND	32.3	ND	258	21	1.1	NA	4	NA	558	140
Big Spring	1.1	ND	1.8	ND	508	250	NA	NA	NA	NA	13.6	2.5
Finch Spring	2	ND	4.4	ND	663	220	0.22	NA	ND	NA	91.7	61
Upper Ledger	3.7	ND	0.92	ND	22.4	2.8	NA	NA	NA	NA	5.1	ND
Lower Ledger	4.2	ND	1.5	ND	54.1	ND	NA	NA	NA	NA	14.9	ND

Footnotes:
* = Point of Compliance Well
NA = Not Available – not sampled during May 2005
ND = Not Detected (less than IDL)
Shaded cells indicate exceedence of RBC

TABLE 3-1

SAMPLING HISTORY AND SAMPLING RATIONALE FOR REMEDIAL DESIGN/ REMEDIAL ACTION GROUND WATER SAMPLING

Well/Sample Location	Source Area Monitored	Round 1 Through 8 Sample Events		Round 9 Through 12 Sample Events		RD/RA Sample Events And Low Flow Sampling		
		Sampled? (Yes/No)	Analytes	Sampled? (Yes/No)	Analytes	Sample Site? (Yes/No)	Analytes	Justification For Sampling/Not Sampling
KM-1 (shallow well paired with KM-10)	Lateral gradient background well	Yes	Long-list metals Round 1-3, short-list metals Rounds 4 through 8, radio-nuclides Rounds 1,3, total chromatographable organics Round 1	Yes	Metals, General Indicators, No organics	No	None	Background sampling not needed; relying on RBC performance standards at POC wells and no statistical background comparison
KM-2 (shallow well)	Active calcine tailing impoundment/former scrubber pond area	Yes	Long-list metals Round 1-3, short-list metals Rounds 4 through 8, radio-nuclides Rounds 1, total chromatographable organics Round 1	Yes	Metals, General Indicators, no organics	Yes	Table 4-3 of RD/RA GW SAP and QAPP; No organics	Point of compliance well, although not truly downgradient of calcine or former scrubber pond; monitor changes in ground water concentrations in conjunction with changes at active calcine impoundment area and scrubber pond closure
KM-3 (shallow well paired with KM-11)	Reclaimed scrubber pond	Yes	Long-list metals Round 1-3, short-list metals Rounds 4 through 8, radio-nuclides Rounds 1,3,4 total chromatographable organics Round 1	Yes	Metals, General Indicators, no organics	Yes	Table 4-3 of RD/RA GW SAP and QAPP; no organics	Point of compliance well; monitor changes in ground concentrations water along southern boundary in conjunction with scrubber pond closure
KM-4 (shallow well)	Active calcine tailing impoundment area	Yes	Long-list metals Round 1-3, short-list metals Rounds 4 through 8, radio-nuclides Rounds 1, 3, total chromatographable organics Round 1	No	None	Yes	Table 4-3 of RD/RA GW SAP and QAPP, no organics	Will provide monitoring of calcine impoundment following capping. Not a POC well

TABLE 3-1

SAMPLING HISTORY AND SAMPLING RATIONALE FOR REMEDIAL DESIGN/ REMEDIAL ACTION GROUND WATER SAMPLING

Well/Sample Location	Source Area Monitored	Round 1 Through 8 Sample Events		Round 9 Through 12 Sample Events		RD/RA Sample Events And Low Flow Sampling		
		Sampled? (Yes/No)	Analytes	Sampled? (Yes/No)	Analytes	Sample Site? (Yes/No)	Analytes	Justification For Sampling/Not Sampling
KM-5 (shallow well)	Historic scrubber pond/historic MAP ponds, Boiler blowdown pond/downgradient of facility	Yes	Long-list metals Round 1-3, short-list metals Rounds 4 through 8, radio-nuclides Rounds 1,3, total chromatographable organics Round 1	Yes	Metals, General Indicators, no organics	Yes	Table 4-3 of RD/RA GW SAP and QAPP; No organics	Point of compliance well, monitors downgradient of northern and central areas of entire plant facility; no active or historic activities downgradient of this location
KM-6 (shallow well)	Historic limestone Settling ponds	Yes	Long-list metals Round 1-3, short-list metals Rounds 4 through 8, radio-nuclides Rounds 1,3, total chromatographable organics Rounds 1, 3	No	None	Yes	Table 4-3 of RD/RA GW SAP and QAPP; no organics	Monitors zone of increased transmissivity on the southern boundary of facility; not a POC well
KM-7 (shallow well)	Historic calcine impoundment area	Yes	Long-list metals Round 1-3, short-list metals Rounds 4 through 8, radio-nuclides Rounds 1,3, total chromatographable organics Round 1	No	None	Yes (2000-->)	Table 4-3 of RD/RA GW SAP and QAPP; no organics	Monitors central portion of the facility and provides additional justification for contouring of COC; not a POC well
KM-8 (shallow well paired with KM-12 and KM-19)	Former S-X pond/ downgradient of plant facility	Yes	Long-list metals Round 1-3, short-list metals Rounds 4 through 8, metals, radionuclides Rounds 1, 4, total chromatograph-able organics Round 1,3, TPH and semivols Rounds 4 and 8	Yes	Metals, General Indicators	Yes	Table 4-3 of RD/RA GW SAP and QAPP	Point of compliance well; monitor changes in ground water concentrations in conjunction with changes from S-X pond closure

TABLE 3-1

SAMPLING HISTORY AND SAMPLING RATIONALE FOR REMEDIAL DESIGN/ REMEDIAL ACTION GROUND WATER SAMPLING

Well/Sample Location	Source Area Monitored	Round 1 Through 8 Sample Events		Round 9 Through 12 Sample Events		RD/RA Sample Events And Low Flow Sampling		
		Sampled? (Yes/No)	Analytes	Sampled? (Yes/No)	Analytes	Sample Site? (Yes/No)	Analytes	Justification For Sampling/Not Sampling
KM-9 (shallow well)	Former S-X pond/downgradient of plant facility	Yes	Long-list metals Round 1-3, short-list metals Rounds 4 through 8, radio-nuclides Rounds 1,3, total chromatographable organics Round 1	Yes	Metals, General Indicators, no organics	Yes	Table 4-3 of RD/RA GW SAP and QAPP; No organics	Point of compliance well, downgradient of entire facility; comparisons can be made with ground water model results to track and evaluate performance
KM-10 (intermediate well, paired with KM-1)	Intermediate depth background well	Yes	Long-list metals Round 1-3, short-list metals Rounds 4 through 8, radio-nuclides Rounds 1,3, total chromatographable organics Round 1	Yes	Metals, General Indicators, no organics	No	None	Background sampling not needed; relying on RBC performance standards at POC wells and no statistical background comparison
KM-11 (intermediate well, paired with KM-3)	Former scrubber pond	Yes	Long-list metals Round 1-3, short-list metals Rounds 4 through 8, radio-nuclides Rounds 1,3, total chromatographable organics Round 1	Yes	Metals, General Indicators, no organics	Yes	Table 4-3 of RD/RA GW SAP and QAPP; No organics	Point of compliance well; monitor changes in ground water concentrations in conjunction with scrubber pond closure
KM-12 (intermediate well paired with KM-8, KM-19)	Former S-X pond/ downgradient of plant facility	Yes	Long-list metals Round 1-3, short-list metals Rounds 4 through 8, radio-nuclides Round 1, total chromatographable organics Round 1	No	None	Yes	Table 4-3 of RD/RA GW SAP and QAPP, no organics	Point of compliance well; monitor changes in ground water concentrations in conjunction with changes from S-X pond closure
KM-13 (shallow well)	Former S-X pond (north end) and downgradient of plant facility	Yes	Long-list metals Round 1-3, short-list metals Rounds 4 through 8, radio-nuclides Round 1, total chromatographable organics Round 1	Yes	Metals, General Indicators, no organics	Yes	Table 4-3 of RD/RA GW SAP and QAPP; no organics	Point of compliance well, downgradient of entire facility

TABLE 3-1

SAMPLING HISTORY AND SAMPLING RATIONALE FOR REMEDIAL DESIGN/ REMEDIAL ACTION GROUND WATER SAMPLING

Well/Sample Location	Source Area Monitored	Round 1 Through 8 Sample Events		Round 9 Through 12 Sample Events		RD/RA Sample Events And Low Flow Sampling		
		Sampled? (Yes/No)	Analytes	Sampled? (Yes/No)	Analytes	Sample Site? (Yes/No)	Analytes	Justification For Sampling/Not Sampling
KM-15 (shallow well, paired with KM-18)	Off-site well southwest of former S-X pond and within main area of impacted ground water	Not completed prior to Round 5	Long-list metals Round 5, short-list metals Rounds 6 through 8, semivols and TPH Rounds 5-8	Yes	Metals, General Indicators	Yes	Table 4-3 of RD/RA GW SAP and QAPP; no organics	Located in off-site area near modeled point; current RBC exceedences of , Mo, and V
KM-16 (shallow well)	Off-site well south of former S-X and settling ponds	Not completed prior to Round 5	Long-list metals Round 5, short-list metals Rounds 6 through 8, semivols and TPH Rounds 5-8	Yes	Metals, General Indicators	Yes	Table 4-3 of RD/RA GW SAP and QAPP, no organics	Located off-site and laterally downgradient of the site; RBC exceedences of Mo, and V
KM-17 (shallow well)	Off-site well southwest of former scrubber pond and active calcine tailing	Not completed prior to Round 5	Long-list metals Round 5, short-list metals Rounds 6 through 8, semivols and TPH Rounds 5-8	Yes	Metals, General Indicators	Yes	Table 4-3 of RD/RA GW SAP and QAPP, no organics	Located off-site and laterally downgradient of the site; RBC exceedences of Mo
KM-18 (intermediate well, paired with KM-15)	Off-site well southwest of former S-X pond, pond and within main area of impacted ground water, paired with KM-15	Not completed prior to Round 5	Long-list metals, semivols and TPH Rounds 5-8	Yes	Metals, General Indicators	Yes	Table 4-3 of RD/RA GW SAP and QAPP, no organics	Monitors deeper aquifer zone for ground water impact; current RBC exceedences Mo, and V
KM-19 (deep well paired with KM-8 and KM-12)	Former S-X pond and downgradient of plant facility	Not completed prior to Round 5	Long-list metals Round 5, short-list metals Rounds 6 through 8, semivols and TPH Round 5	No	None	Yes	Table 4-3 of RD/RA GW SAP and QAPP; no organics	Point of compliance well; monitor changes in ground water concentrations in conjunction with changes from S-X pond closure

TABLE 3-1

SAMPLING HISTORY AND SAMPLING RATIONALE FOR REMEDIAL DESIGN/ REMEDIAL ACTION GROUND WATER SAMPLING

Well/Sample Location	Source Area Monitored	Round 1 Through 8 Sample Events		Round 9 Through 12 Sample Events		RD/RA Sample Events And Low Flow Sampling		
		Sampled? (Yes/No)	Analytes	Sampled? (Yes/No)	Analytes	Sample Site? (Yes/No)	Analytes	Justification For Sampling/Not Sampling
Finch Spring (spring discharging from base of Finch Fault to surface water)	Spring south of facility which has appeared to be impacted primarily from scrubber discharge	Yes	Long-list metals Round 1-3, short-list metals Rounds 4 through 8, long-list metals, semivols and TPH Round 5	Yes	Metals, General Indicators	Yes	Table 4-3 of RD/RA GW SAP and QAPP, no organics	Monitor downgradient changes to ground water from scrubber pond closure and other remedial actions on-site, current RBC exceedence of Mo
Big Spring (spring discharging to surface water flowing to Bear River)	Spring south of Soda Springs, furthest south discharge identified from Bear River Basin to Bear River	Not sampled prior to Round 6	Short-list metals	Yes	Metals, General Indicators, no organics	Yes	Table 4-3 of RD/RA GW SAP and QAPP, no organics	Current exceedence of Mo RBC, too far from plant to measure direct changes associated with remedial actions; other influencing factor contributing to ground water upgradient of site and downgradient of KMCC, will continue to monitor
Upper Ledge(r) Spring (spring discharging from Ledger Creek drainage, between Kelley Park and Rabbit Mountain	An important source of drinking water for the town of Soda Springs. EPA requested additional monitoring of this spring by KMC LLC following public meeting and on amended ROD comments in June 2000.	1 Event (no impacts noted)	Long-list metals Round 1	No	None	Yes	Table 4-3 of RD/RA GW SAP and QAPP, no organics	Monitor ground water quality
Lower Ledge(r) Spring (spring discharging from Ledger Creek drainage, between Kelley Park and Rabbit Mountain	An important source of drinking water for the town of Soda Springs. EPA requested additional monitoring of this spring by KMC LLC following public meeting and on amended ROD comments in June 2000.	1 Event (no impacts noted)	Long-list metals Round 1	No	None	Yes	Table 4-3 of RD/RA GW SAP and QAPP, no organics	Monitor ground water quality

**TABLE 5-1
CHRONOLOGY OF PROCESS CHANGES**

Event	Date(s)	Comments
S-X stream diverted from the S-X pond to the scrubber pond	1992 through 1993	Flow may have been diverted between ponds during this time period.
MAP ponds taken out of service; third roaster taken off-line in April	1993	Ponds reclaimed. Effects of remediation apparent in well KM-5.
S-X pond receiving discharge from S-X circuit	1994	S-X circuit discharge diverted to S-X pond for last time.
S-X stream diverted from the S-X pond to the scrubber pond	Late 1994 to mid 1995	S-X pond contained residual process water during 1995
S-X stream diverted to newly-constructed lined ponds	Mid 1995	Precipitation continued to fill the S-X pond basin and infiltrate. Pond contained significant volume of precipitation during 1996-1997 winter.
Scrubber pond taken out of service	April 1997	Scrubber pond pumped to the calcine pond. Some scrubber stream sent to calcine ponds. Residual liquid in pond and meteoric water drained out during stabilization of the pond sediments. All baghouses on-line in October.
Discontinue sluicing calcine	April – October 1997	Calcine dewatered, and residual water recycled in process. Dewatered calcine stockpiled north of the calcine impoundment.
Fertilizer Plant Operational	July 1998 to May 2000	Calcine removed from active calcine Impoundment, processed to fertilizer. Reject fertilizer placed in calcine impoundment.
Discontinue Vanadium Processing – Vanadium Plant Idle	January 1999 to present	Discontinue stockpiling of calcine, discontinue all vanadium process streams to lined ponds, discontinue the recycle of roaster reject.
Cap Active Calcine Impoundment	May 2001 through August 2001	Calcine was capped using multi-component cover to eliminate meteoric infiltration through calcine tailing. Substantial amount of dust control/construction water used.
Dismantle Vanadium Plant	November 2001 through May 2002	Materials removed to approved facility, surface footprint cleaned in preparation for surface regrade. Footprint regraded with limestone fines in April/May 2003
Dismantle Fertilizer Plant	November 2002 through June 2003	Materials removed to approved facility, surface footprint cleaned in preparation for surface regrade.
Reclaim Stormwater Runoff Ponds	September through October 2003	Solids and liquids removed to 10-acre pond, site regraded and reclaimed.
Reclaim 5-Acre Ponds	September through October 2004	Solids and liquids removed to 10-acre pond, east pond site regraded and reclaimed.

Note: Changes in the discharge locations of both the S-X and scrubber streams affected concentrations in both on-site and off-site wells and Finch Spring during operation.

TABLE 6-1
SUMMARY OF PROJECTED COC TRENDS

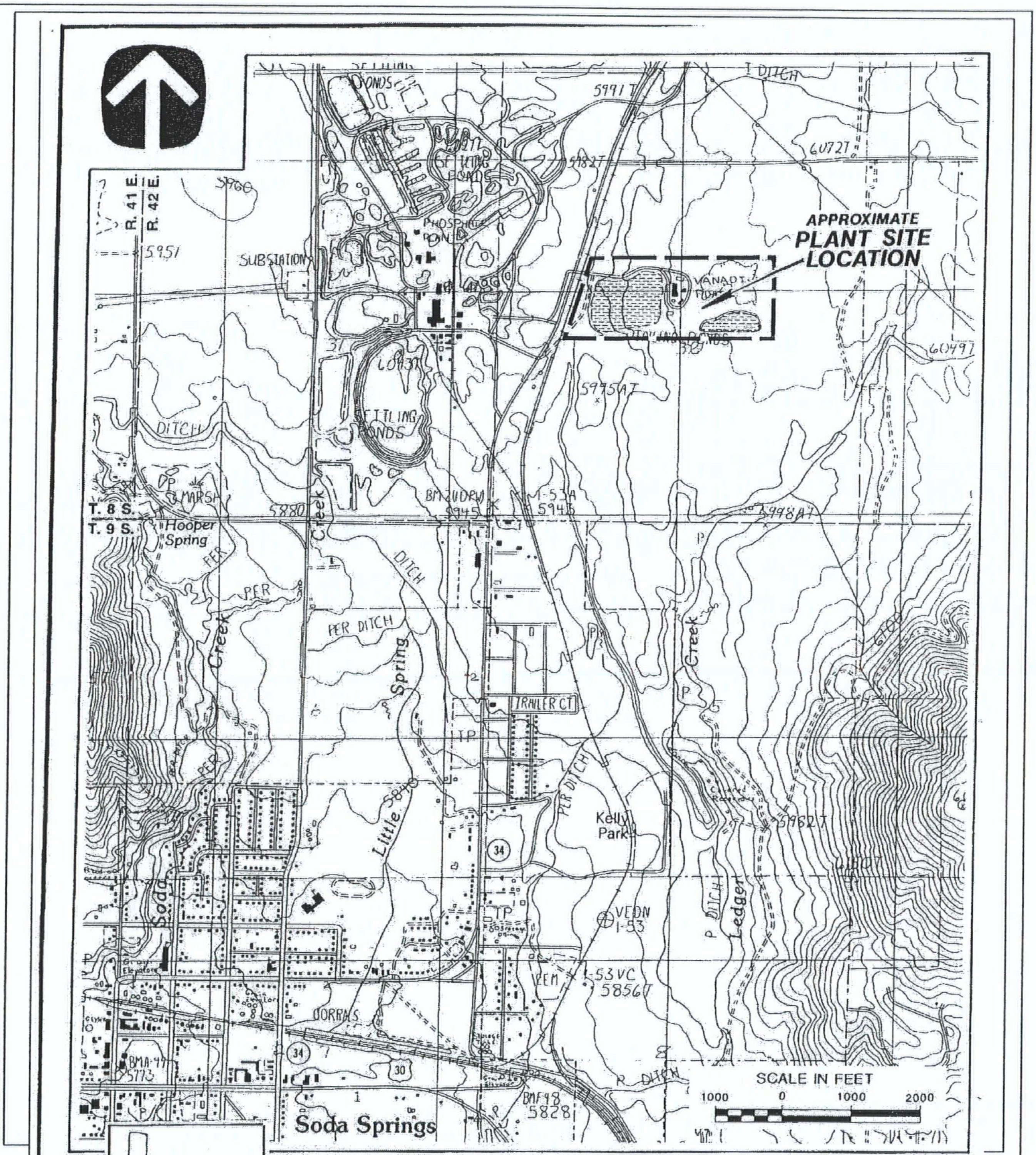
Well Designation	Manganese Concentrations RBC = 180 ug/l		Molybdenum Concentrations RBC = 180 ug/l		Vanadium Concentrations RBC = 260 ug/l	
	Most Current (ug/l)	Projected Year Below RBC	Most Current (ug/l)	Projected Year Below RBC	Most Current (ug/l)	Projected Year Below RBC
KM-2*	55	NE	1300	>2015	4200	>2015
KM-3*	530	NE	7700	>2015	5200	>2015
KM-4	100	NE	2700	NE	4200	NE
KM-5*	3.5	NE	190	2003	1300	2012
KM-6	210	NE	1400	>2015	3800	>2015
KM-7	110	NE	430	NE	2400	NE
KM-8*	3000	2018	49000	>2015	17000	ND
KM-9*	6.7	NE	210	2003	450	2008
KM-11*	19	NE	390	NE	10	NE
KM-12*	30	NE	590	2011	750	2016
KM-13*	13	NE	320	2006	510	2009
KM-15	68	NE	490	2006	930	>2015
KM-16	120	NE	840	2014	2200	>2015
KM-17	4.2	NE	510	ND	4.3	NE
KM-18	51	NE	460	2007	720	2013
KM-19*	ND	NE	21	NE	140	NE

Shaded Numbers Indicate Exceedence of RBC

Footnotes:

*   = Point of Compliance Well
NE = Well not used for COC projection trend
ND = Can not assess trend based on current monitoring data following LSE

FIGURES



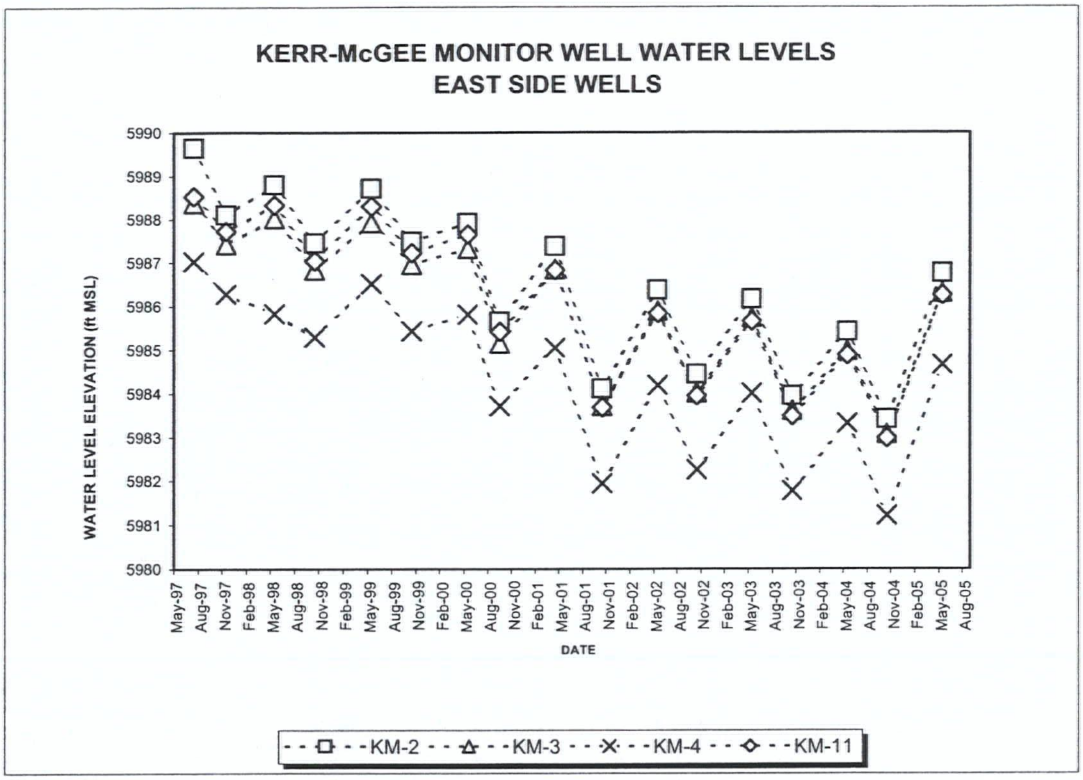
2005 ANNUAL COMPREHENSIVE
GROUND WATER REPORT

KERR-McGEE CHEMICAL LLC
SODA SPRINGS, IDAHO FACILITY
LOCATION MAP

FIGURE 1-1

REFERENCE: U.S.G.S. QUADRANGLE
SODA SPRINGS, IDAHO PROVISIONAL
EDITION 1982.

WATER LEVELS VERSUS TIME
KERR-McGEE CHEMICAL LLC ON-SITE WELLS
FOLLOWING LSE AND POND RECLAMATION



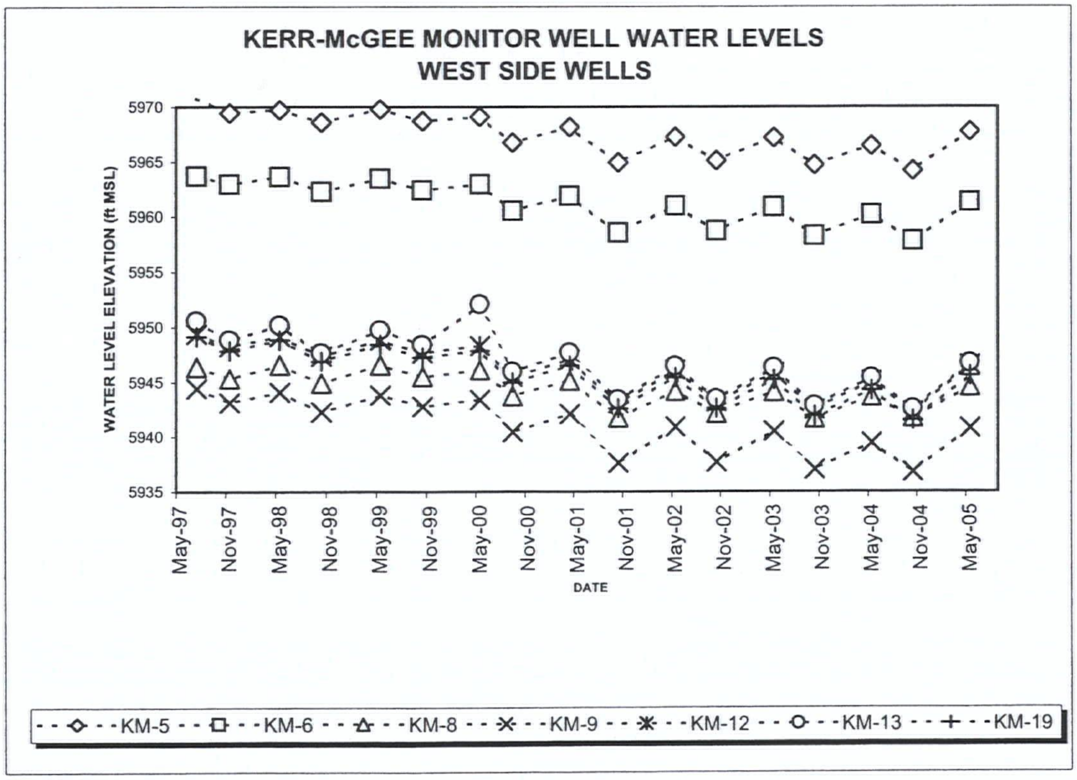
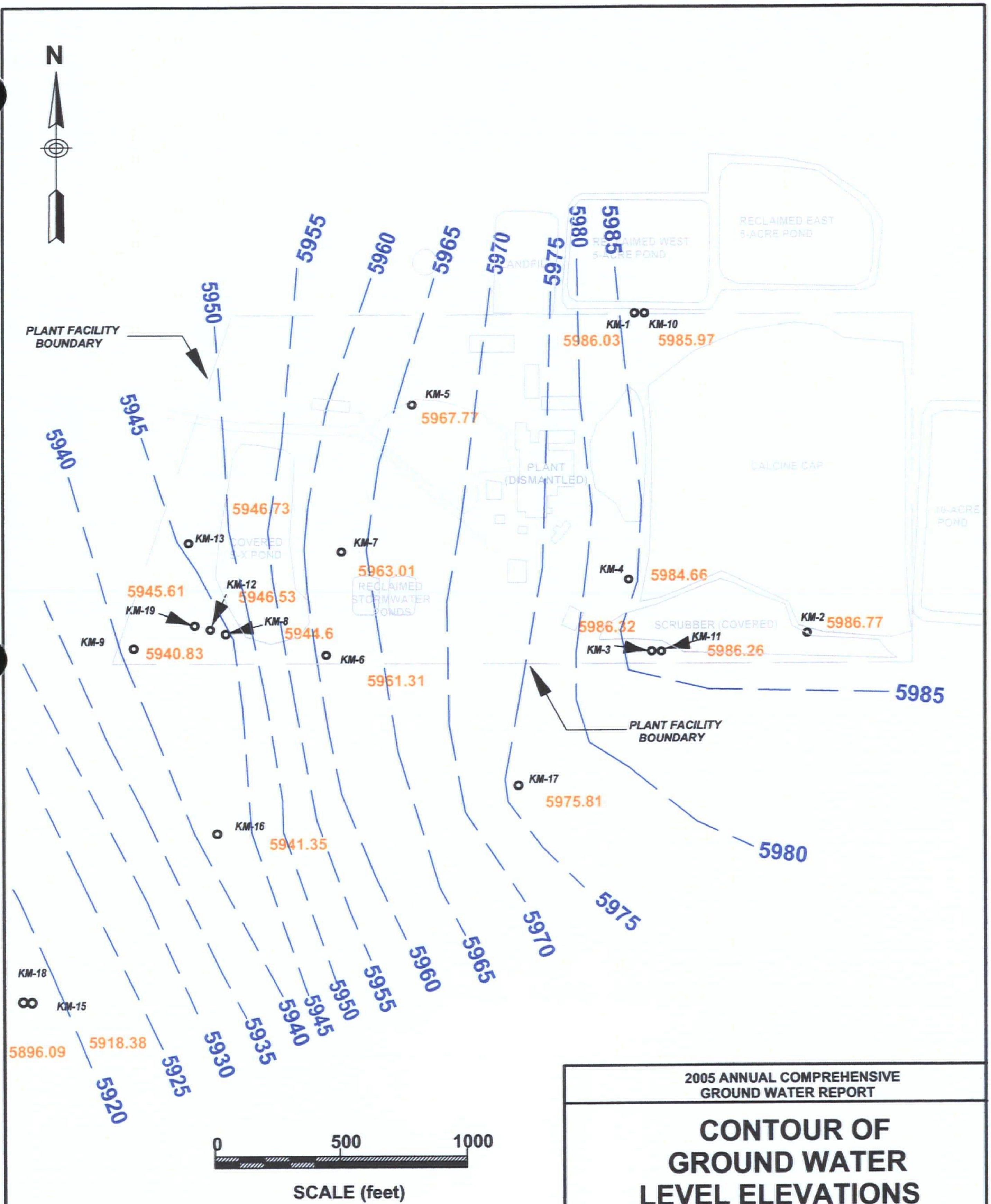


FIGURE 1-3



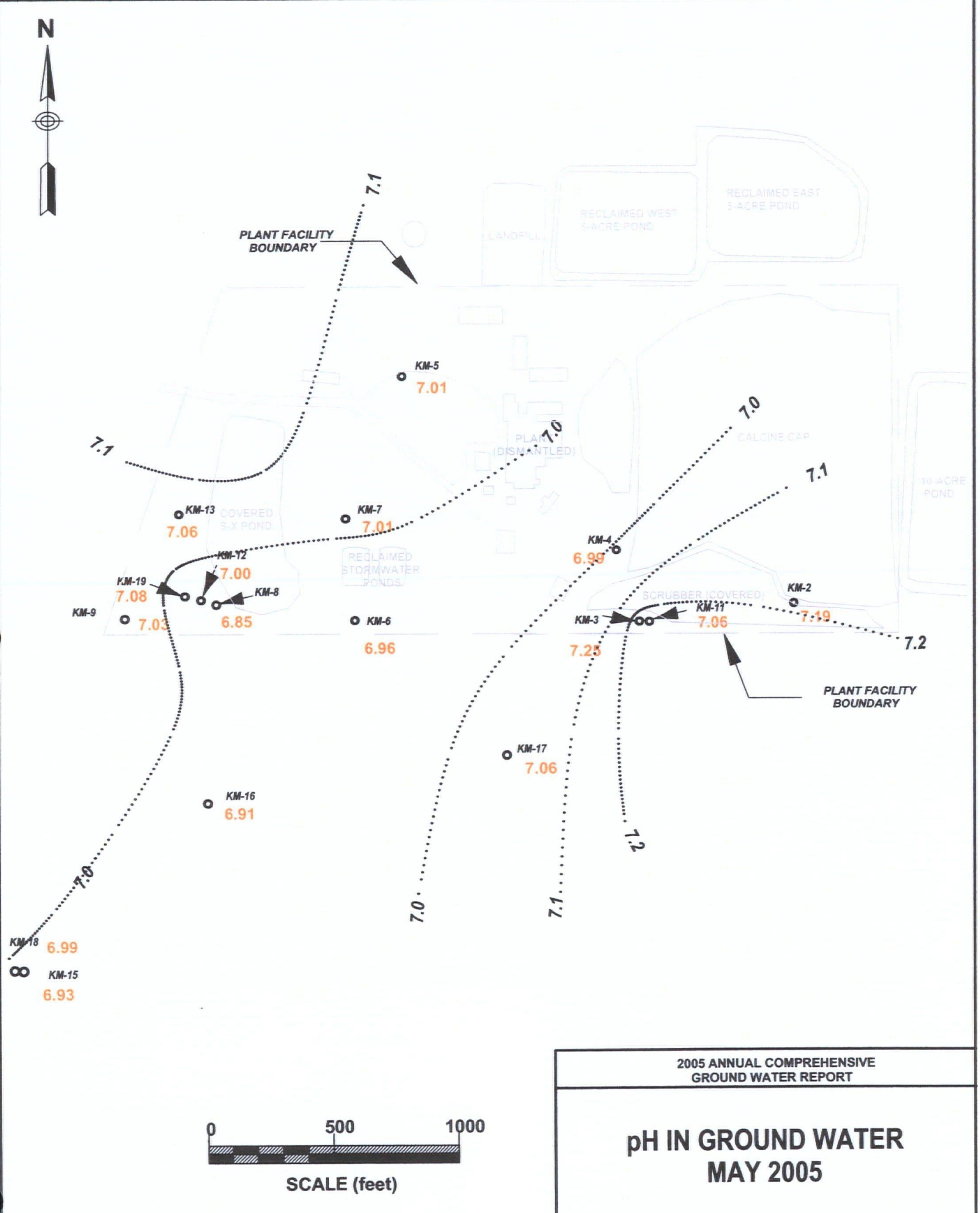
2005 ANNUAL COMPREHENSIVE GROUND WATER REPORT

CONTOUR OF GROUND WATER LEVEL ELEVATIONS MAY 2005

NOTE: CONTOURS BASED ON GROUND WATER LEVELS IN SHALLOW WELLS

KERR-McGEE CHEMICAL LLC
SODA SPRINGS, IDAHO

FIGURE 1-2



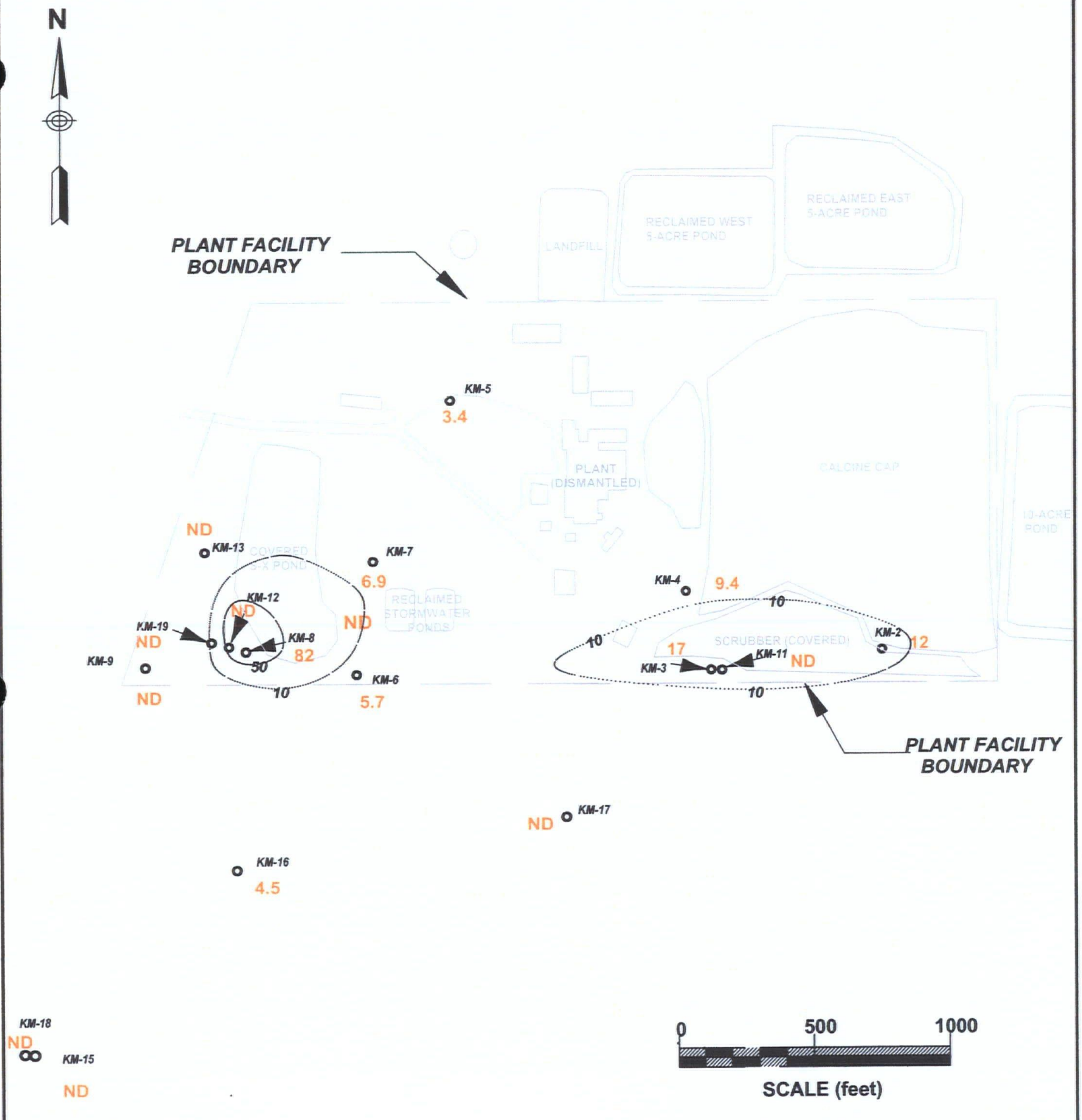
NOTE: CONCENTRATIONS ARE IN pH units.
CONCENTRATIONS BASED ON OBSERVED CONCENTRATIONS IN SHALLOW AQUIFER.

2005 ANNUAL COMPREHENSIVE GROUND WATER REPORT

pH IN GROUND WATER MAY 2005

KERR-McGEE CHEMICAL LLC
SODA SPRINGS, IDAHO

FIGURE 4-1

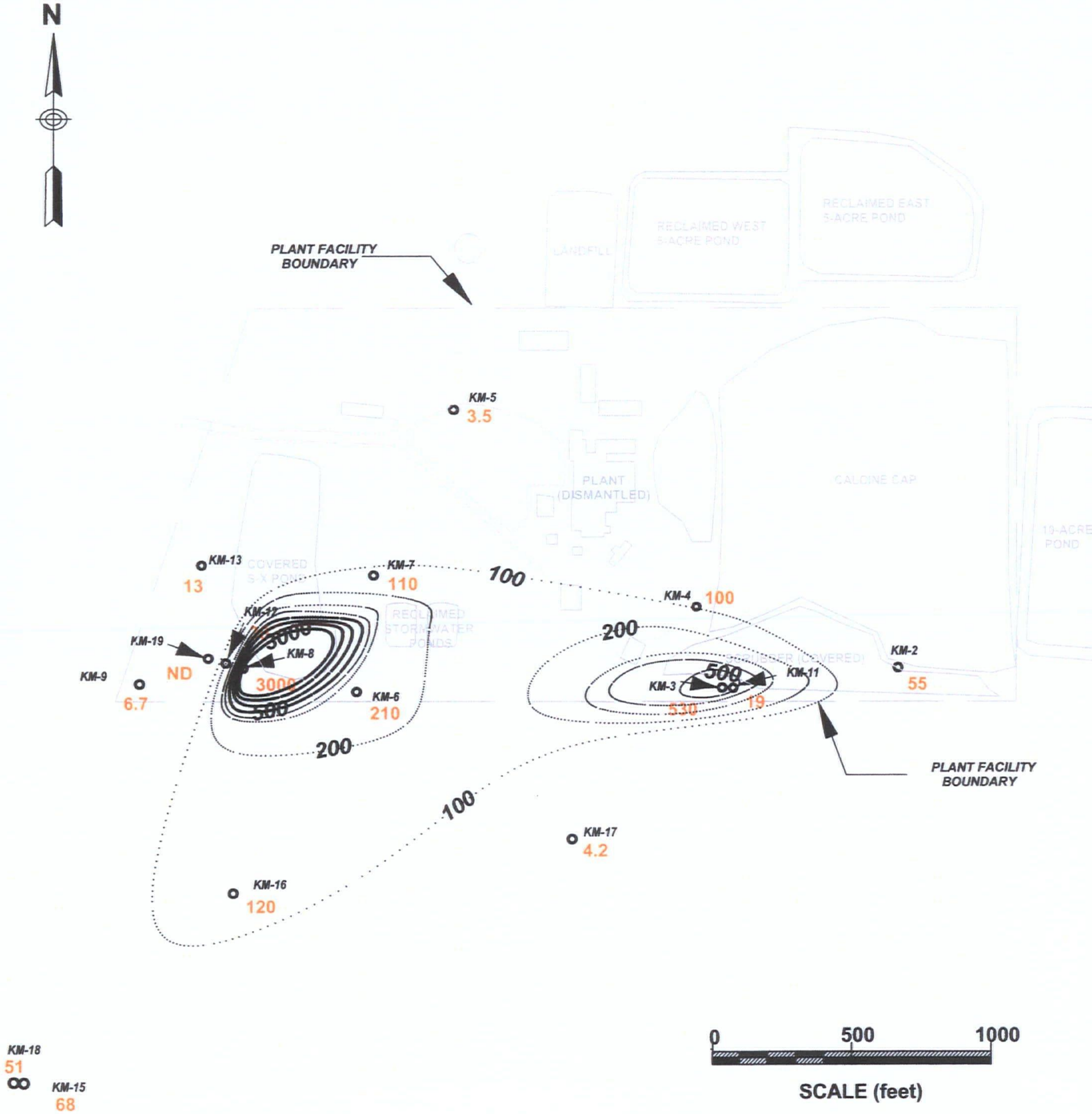


NOTE: CONCENTRATIONS ARE IN ug/l.
CONTOURS BASED ON CONCENTRATIONS IN SHALLOW AQUIFER.

RBC FOR ARSENIC IS 50 ug/l

NOTE: CONCENTRATIONS LESS THAN THE METHOD DETECTION LIMIT OF 15 ug/l ARE FLAGGED AS ESTIMATED

2005 ANNUAL COMPREHENSIVE GROUND WATER REPORT	
CONCENTRATIONS OF ARSENIC IN GROUND WATER MAY 2005	
KERR-McGEE CHEMICAL LLC SODA SPRINGS, IDAHO	FIGURE 4-2



NOTE: CONCENTRATIONS ARE IN ug/l.
CONTOURS BASED ON CONCENTRATIONS IN SHALLOW AQUIFER.

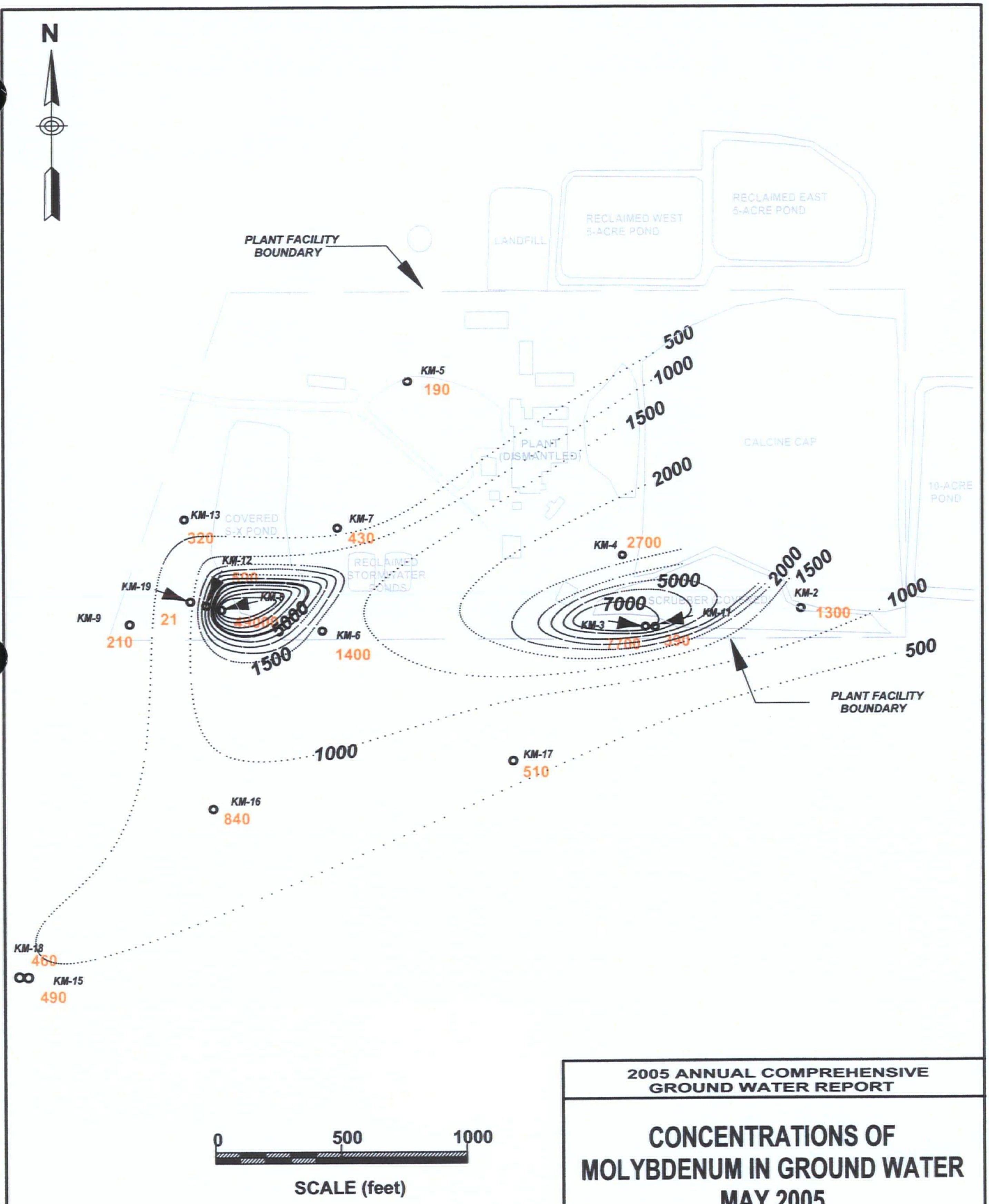
RBC FOR MANGANESE IS 180 ug/l

2005 ANNUAL COMPREHENSIVE GROUND WATER REPORT

CONCENTRATIONS OF MANGANESE IN GROUND WATER MAY 2005

KERR-McGEE CHEMICAL LLC
SODA SPRINGS, IDAHO

FIGURE 4-3



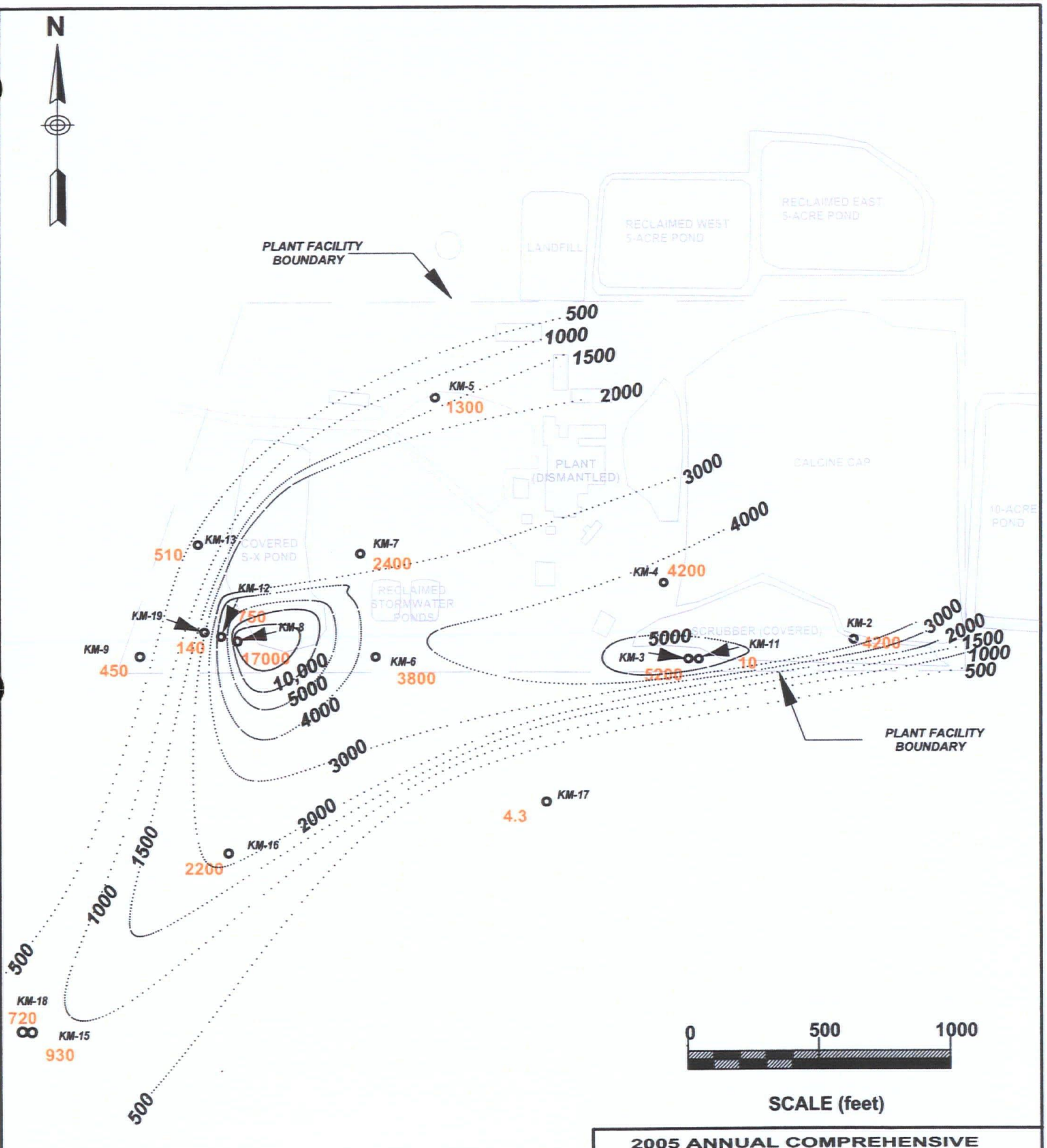
NOTE: CONCENTRATIONS ARE IN ug/l.
CONTOURS BASED ON CONCENTRATIONS
IN SHALLOW AQUIFER.
RBC FOR MOLYBDENUM IS 180 ug/l.

2005 ANNUAL COMPREHENSIVE
GROUND WATER REPORT

CONCENTRATIONS OF MOLYBDENUM IN GROUND WATER MAY 2005

KERR-McGEE CHEMICAL LLC
SODA SPRINGS, IDAHO

FIGURE 4-4



NOTE: CONCENTRATIONS ARE IN ug/l.
CONCENTRATIONS BASED ON OBSERVED CONCENTRATIONS IN SHALLOW AQUIFER.

RBC FOR VANADIUM IS 260 ug/l .

2005 ANNUAL COMPREHENSIVE GROUND WATER REPORT

CONCENTRATIONS OF VANADIUM IN GROUND WATER MAY 2005

KERR-McGEE CHEMICAL LLC
SODA SPRINGS, IDAHO

FIGURE 4-5

LEDGER SPRING SAMPLING, SODA SPRINGS, IDAHO 2001
WED 08-17-19:5 12:10:22.13

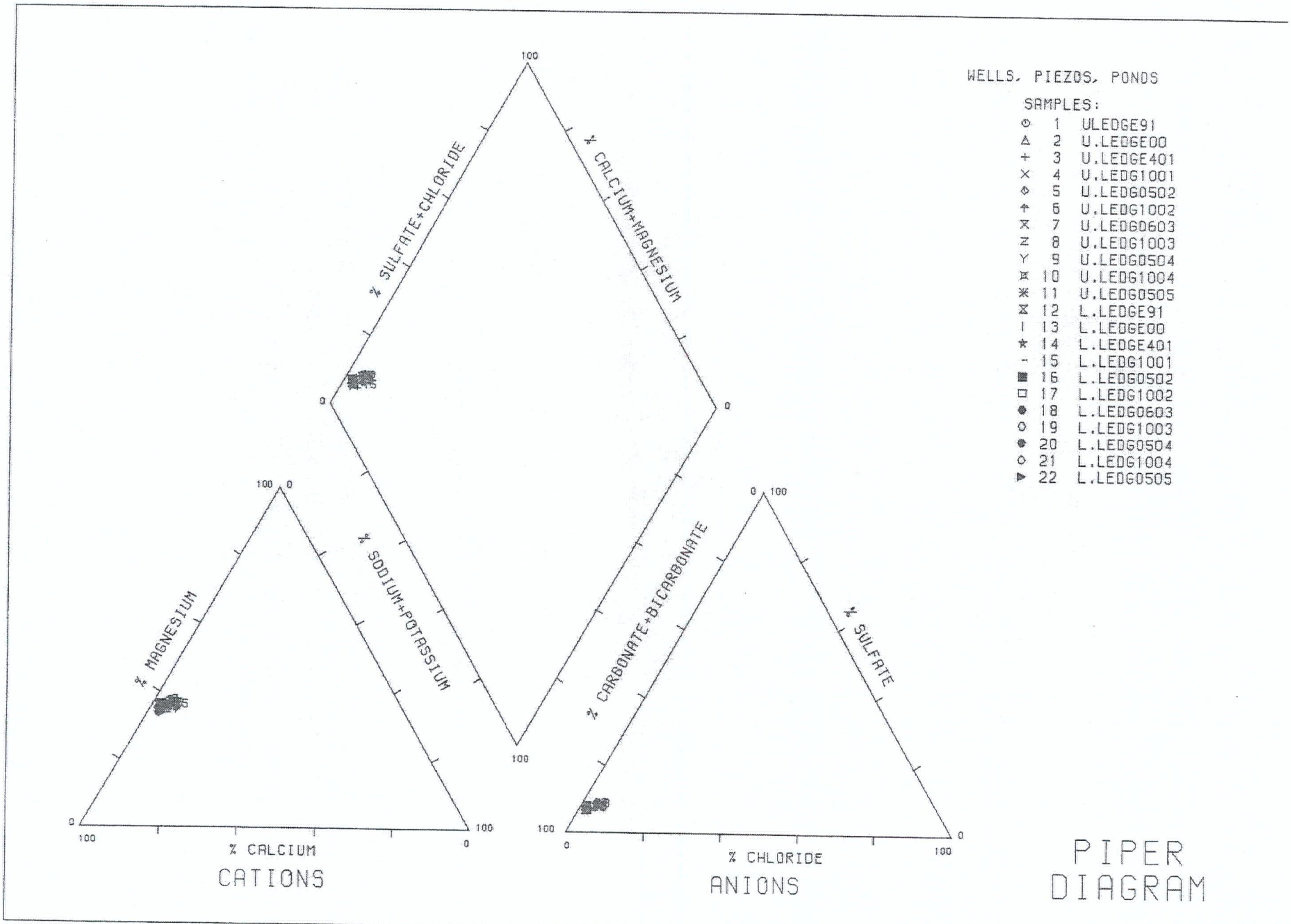


FIGURE 5-1

SPRING SAMPLING, SODA SPRINGS, IDAHO 2005
WED 08-17-19:5

13:11:14.30

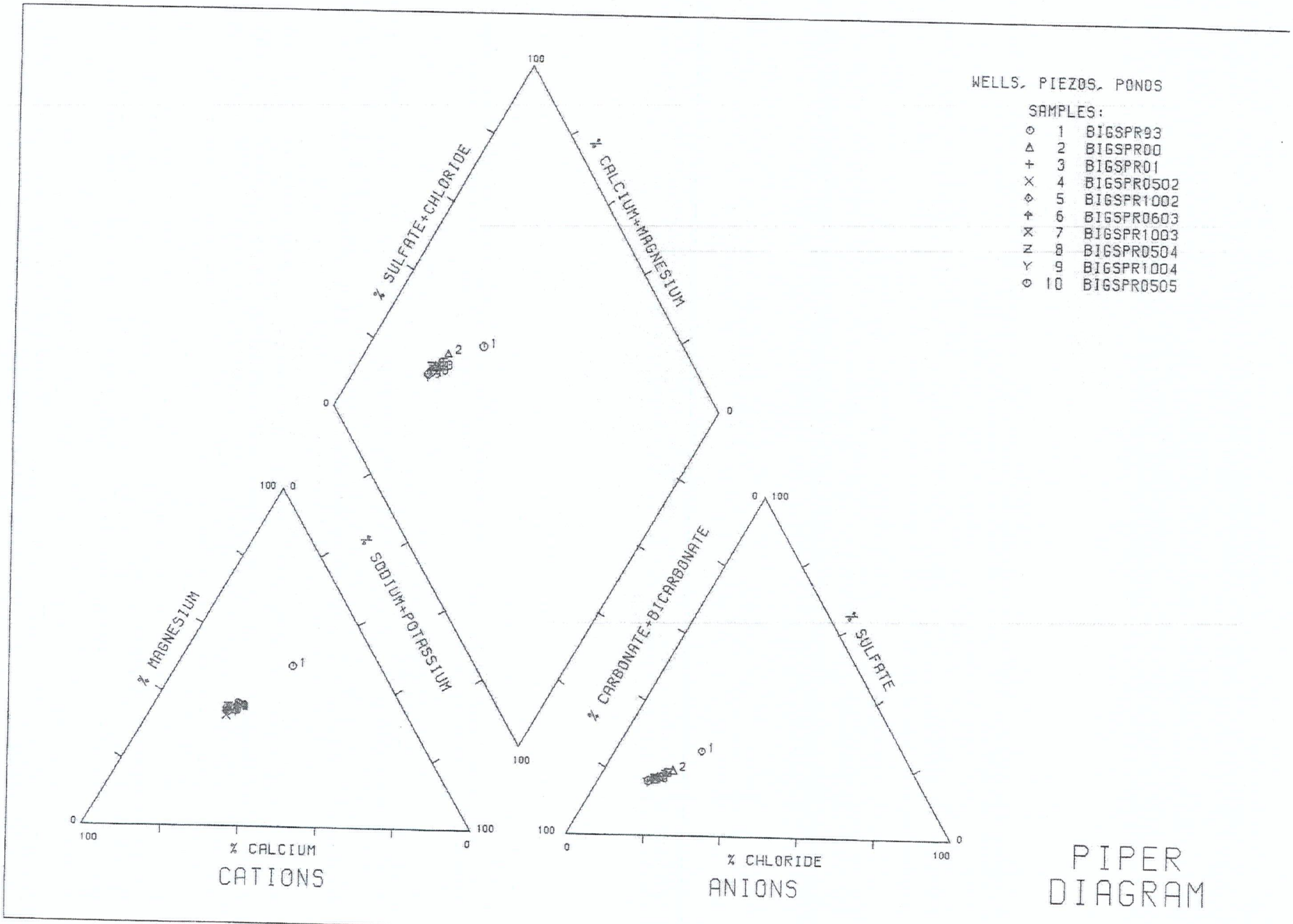
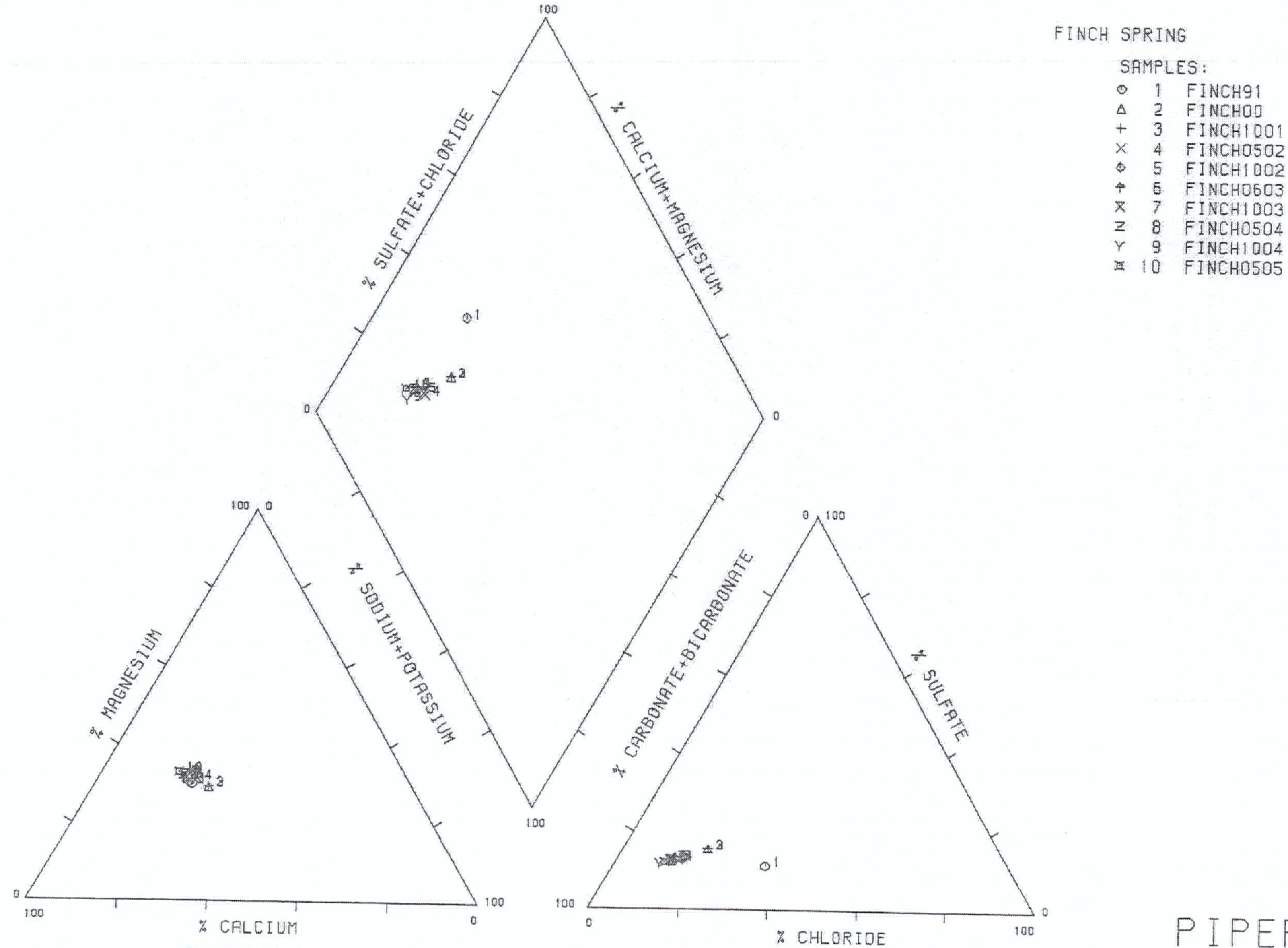


FIGURE 5-2

SPRING SAMPLING, SODA SPRINGS, IDAHO 2005
WED 08-17-19:5 13:24:53.67



PIPER DIAGRAM

FIGURE 5-3

SPRING SAMPLING. SODA SPRINGS. IDAHO 2003
WED 08-17-19:5

14:13:11.43

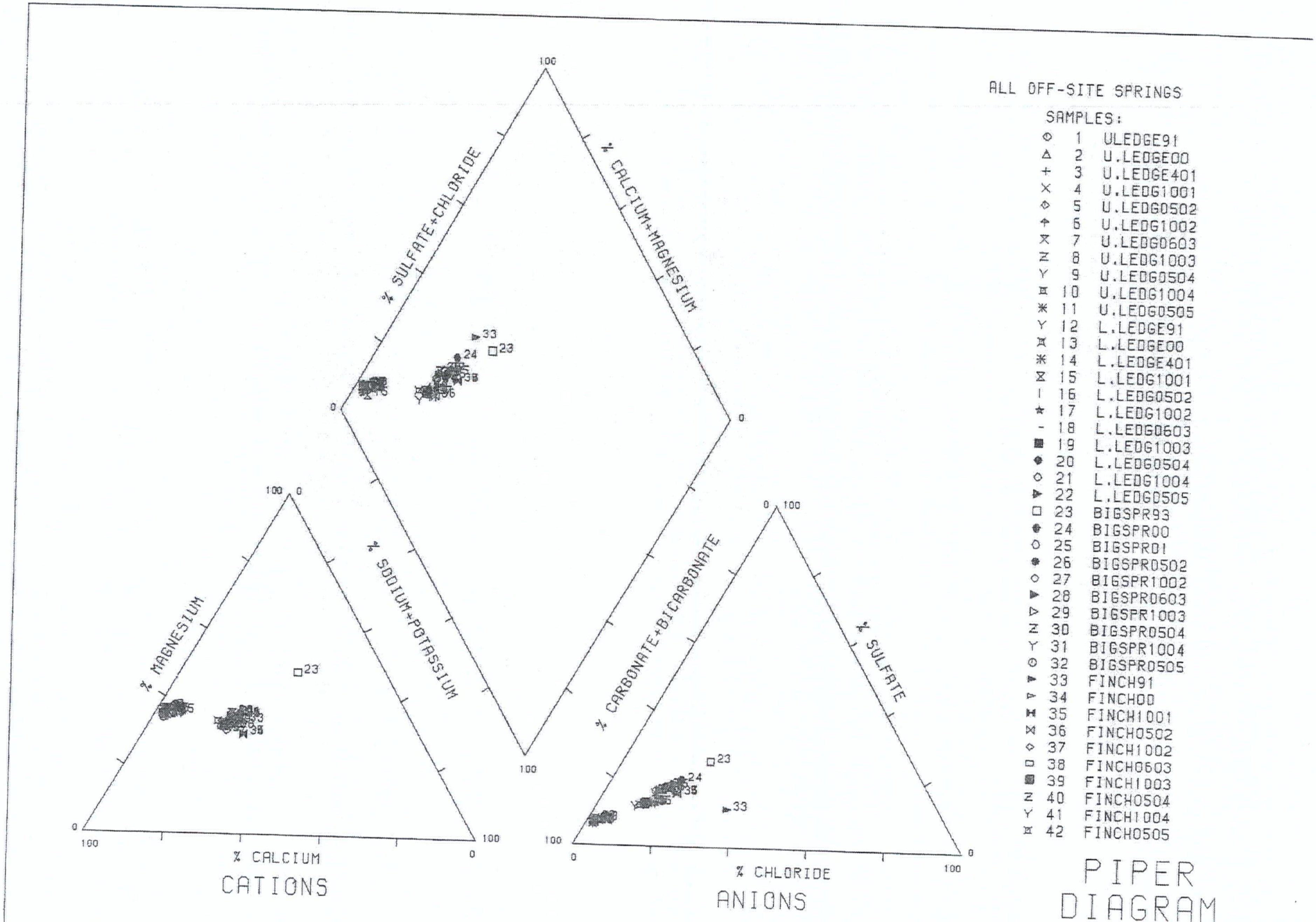
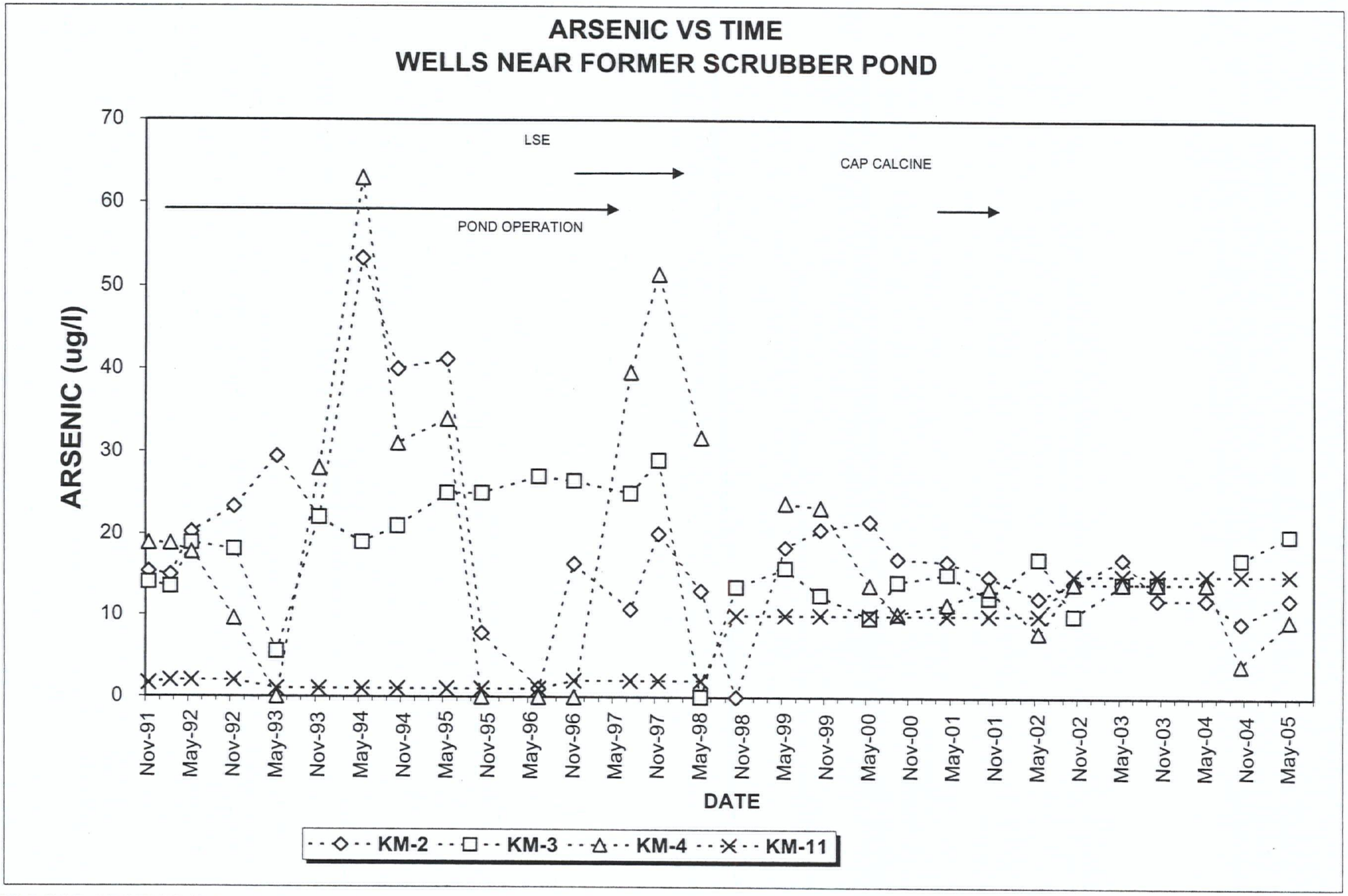


FIGURE 5-4

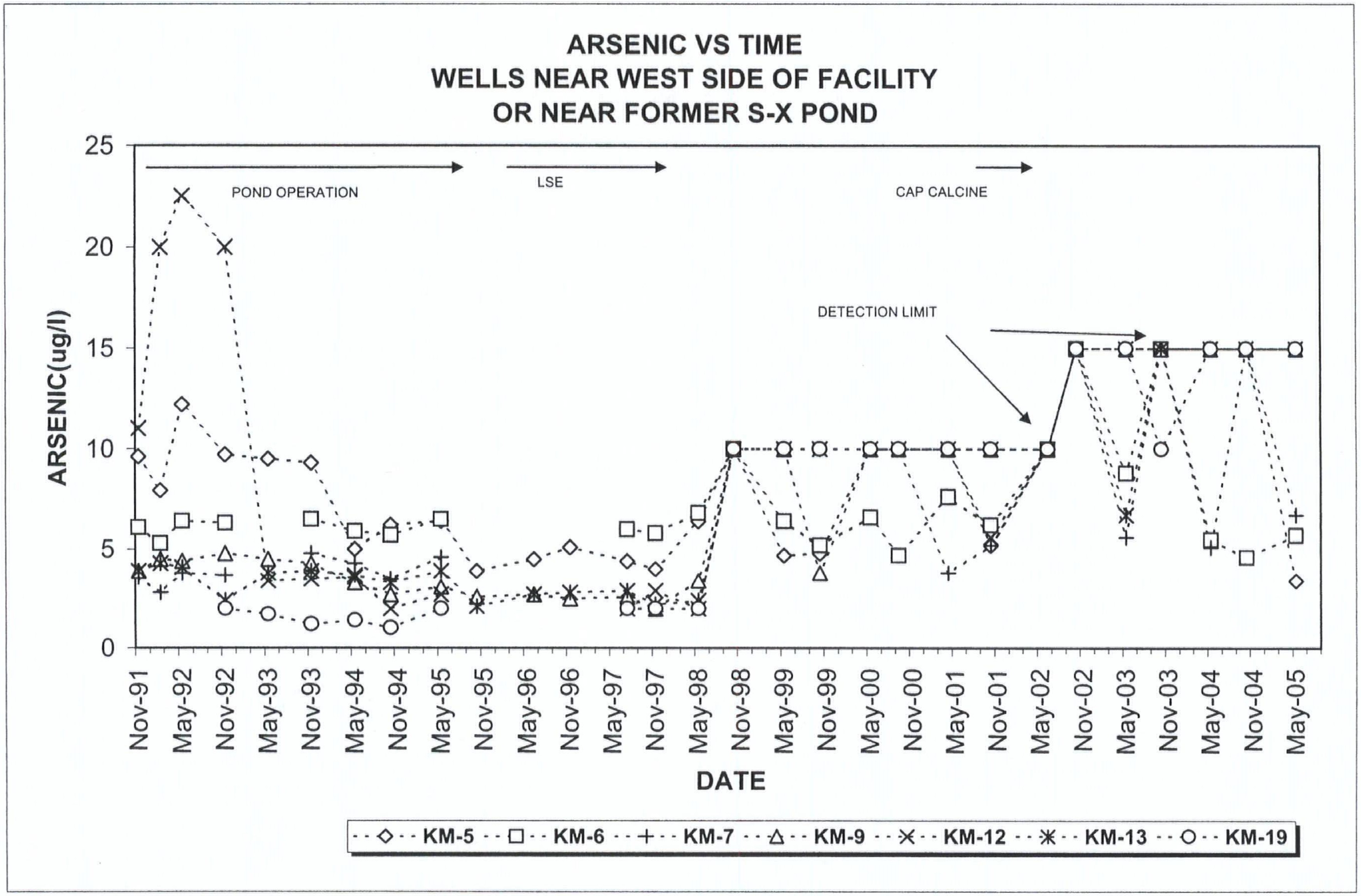
Appendix A

APPENDIX A

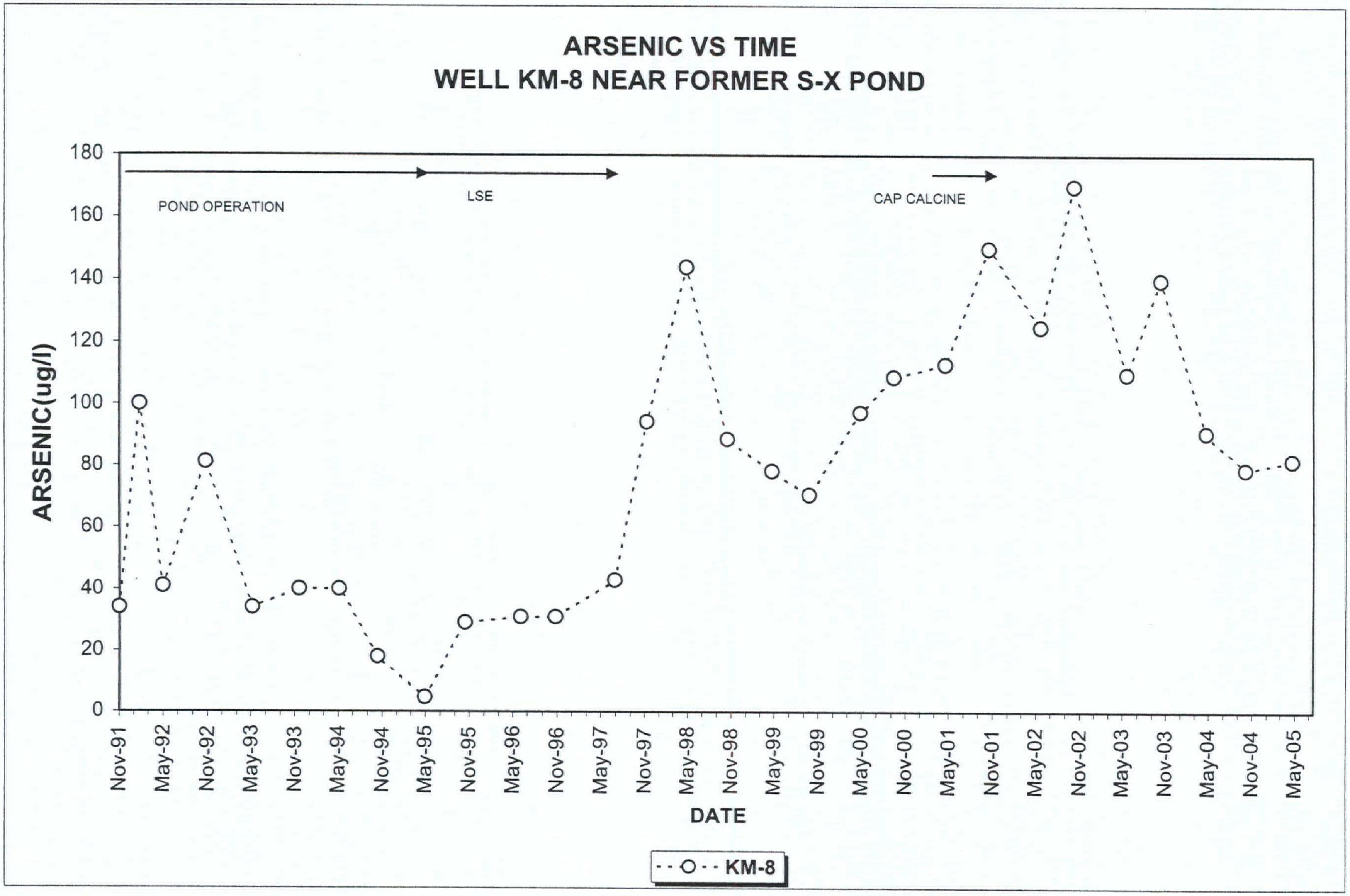
GRAPHS OF GROUND AND SURFACE WATER QUALITY VERSUS TIME



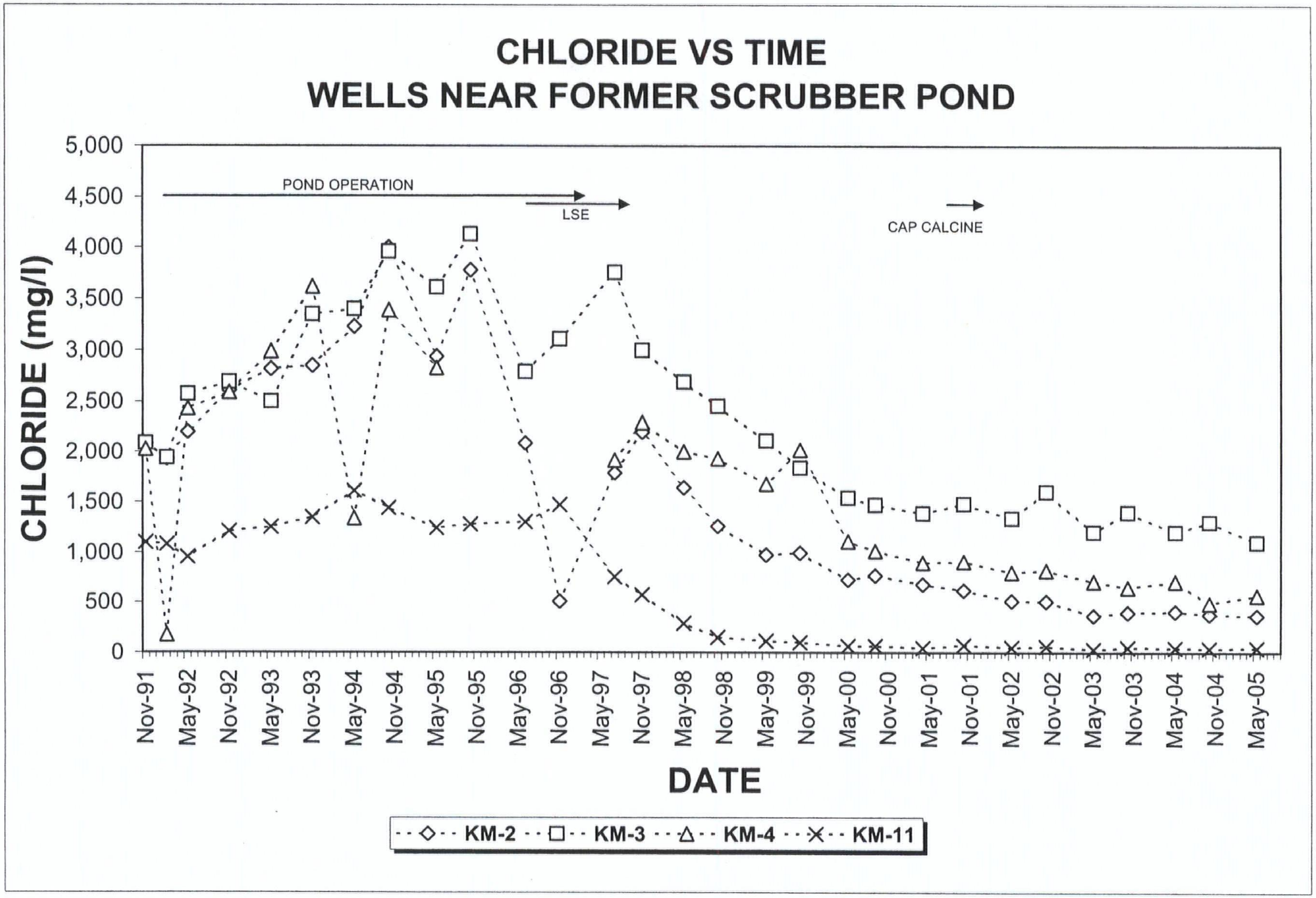
RBC FOR ARSENIC IS 50 ug/l
KM-2, KM-3, KM-11 ARE POC WELLS
VALUES LESS THAN DETECTION ARE PLOTTED AT DETECTION LIMIT
ARSENIC DETECTION LIMIT AT 10 to 15 UG/L 1999 THROUGH 2005

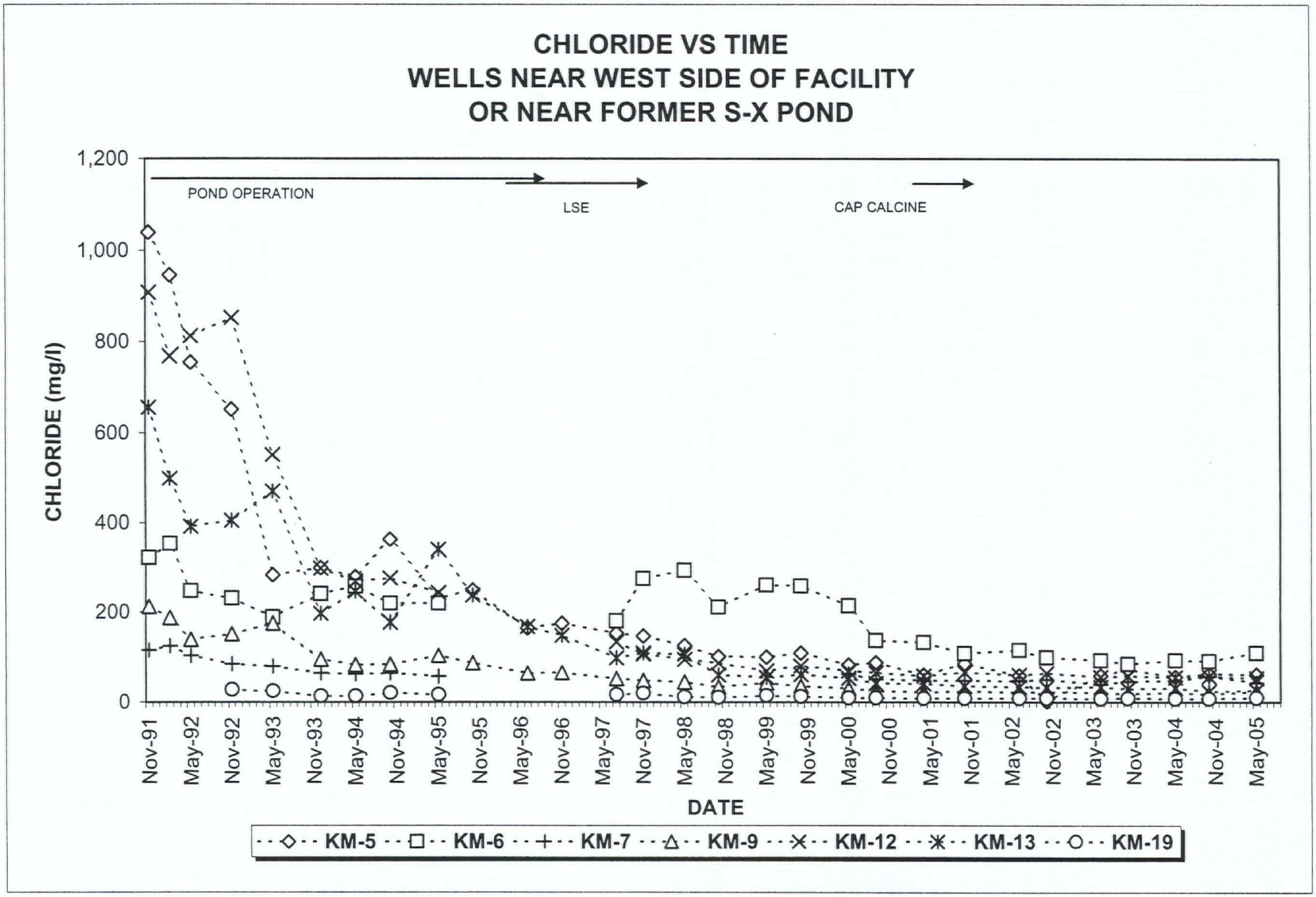


RBC FOR ARSENIC IS 50 ug/l
KM-5, KM-9, KM-12, KM-13, KM-19 ARE POC WELLS
VALUES LESS THAN DETECTION ARE PLOTTED AT THE DETECTION LIMIT
ARSENIC IS LESS THAN DETECTION OR REPORTING LIMIT IN ALL WELLS DURING 2003 through 2005



RBC FOR ARSENIC IS 50 ug/l
KM-8 IS A POC WELL
VALUES LESS THAN DETECTION ARE PLOTTED AT THE DETECTION LIMIT


CHLORIDE VS TIME
WELLS NEAR FORMER SCRUBBER POND
CHLORIDE (mg/l)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
POND OPERATION
LSE
CAP CALCINE
Nov-91
May-92
Nov-92
May-93
Nov-93
May-94
Nov-94
May-95
Nov-95
May-96
Nov-96
May-97
Nov-97
May-98
Nov-98
May-99
Nov-99
May-00
Nov-00
May-01
Nov-01
May-02
Nov-02
May-03
Nov-03
May-04
Nov-04
May-05
DATE
KM-2
KM-3
KM-4
KM-11


CHLORIDE VS TIME
WELLS NEAR WEST SIDE OF FACILITY
OR NEAR FORMER S-X POND
POND OPERATION
LSE
CAP CALCINE
CHLORIDE (mg/l)
1,200
1,000
800
600
400
200
0
Nov-91
May-92
Nov-92
May-93
Nov-93
May-94
Nov-94
May-95
Nov-95
May-96
Nov-96
May-97
Nov-97
May-98
Nov-98
May-99
Nov-99
May-00
Nov-00
May-01
Nov-01
May-02
Nov-02
May-03
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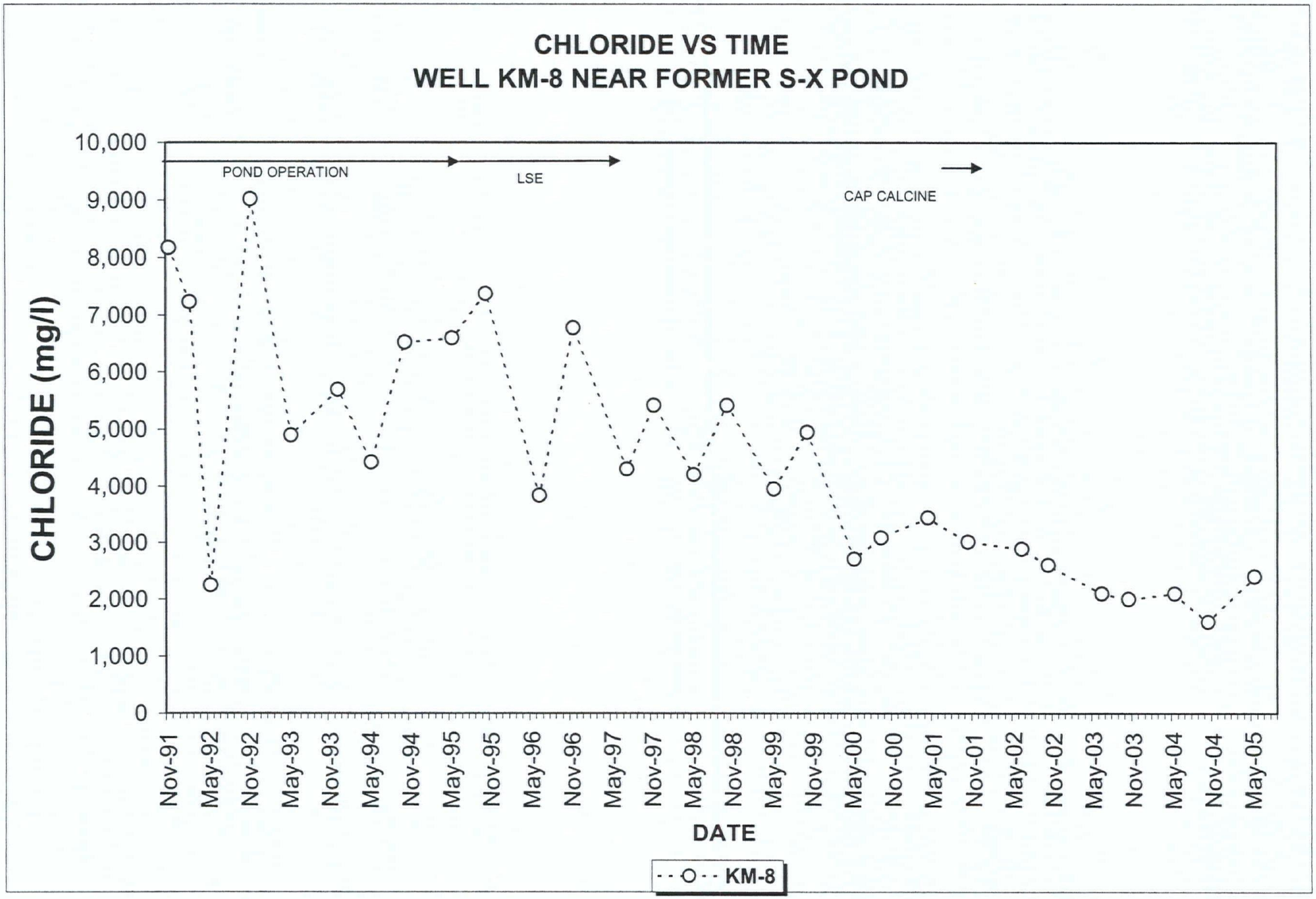
Nov-04
May-05
DATE
KM-5
KM-6
KM-7
KM-9
KM-12
KM-13
KM-19


CHLORIDE VS TIME
WELL KM-8 NEAR FORMER S-X POND
POND OPERATION
LSE
CAP CALCINE
CHLORIDE (mg/l)
10,000
9,000
8,000
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
Nov-91
May-92
Nov-92
May-93
Nov-93
May-94
Nov-94
May-95
Nov-95
May-96
Nov-96
May-97
Nov-97
May-98
Nov-98
May-99
Nov-99
May-00
Nov-00
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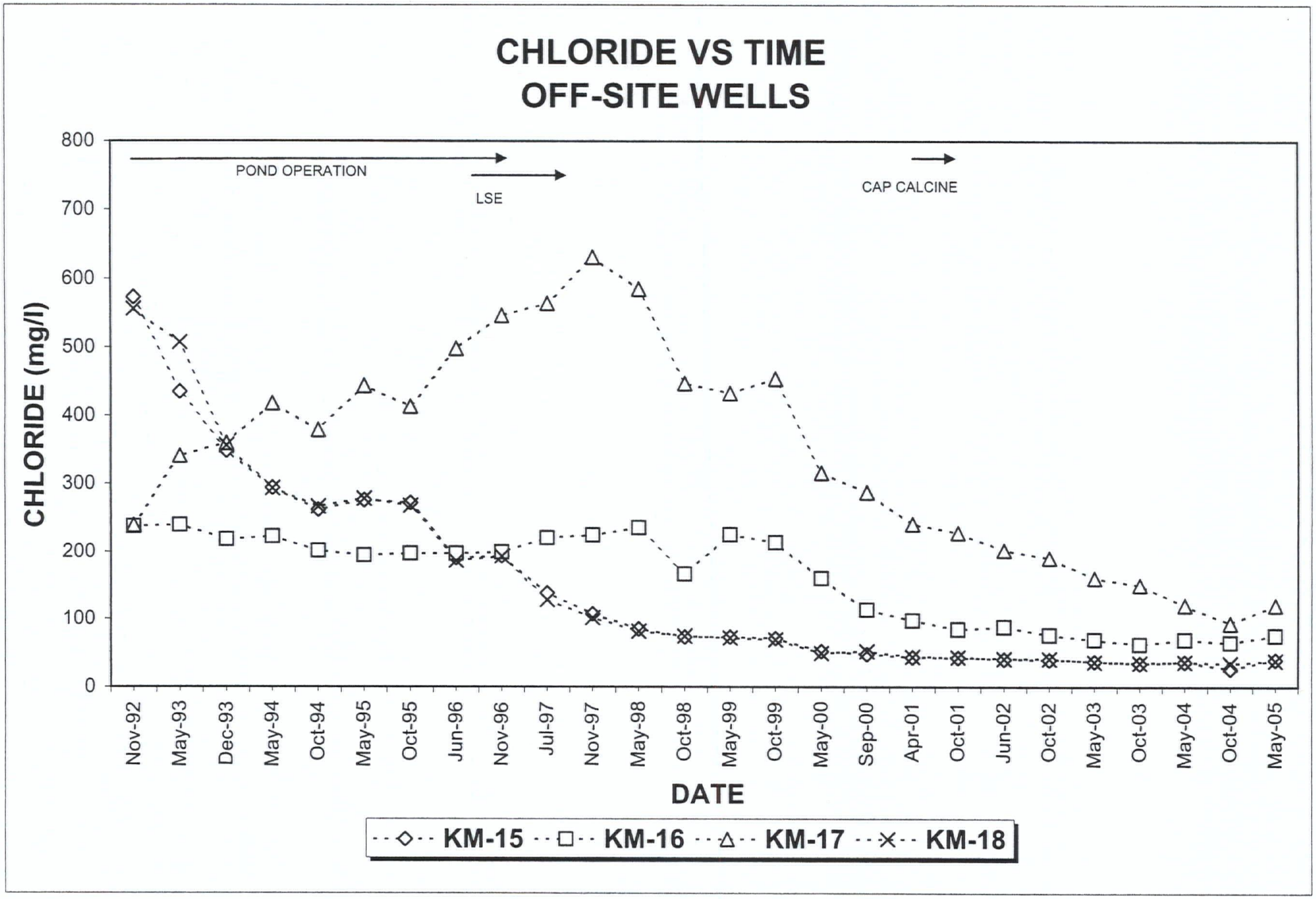
Nov-01
May-02
Nov-02
May-03
Nov-03
May-04
Nov-04
May-05
DATE
KM-8


CHLORIDE VS TIME
OFF-SITE WELLS
CHLORIDE (mg/l)
800
700
600
500
400
300
200
100
0
POND OPERATION
LSE
CAP CALCINE
Nov-92
May-93
Dec-93
May-94
Oct-94
May-95
Oct-95
Jun-96
Nov-96
Jul-97
Nov-97
May-98
Oct-98
May-99
Oct-99
May-00
Sep-00
Apr-01
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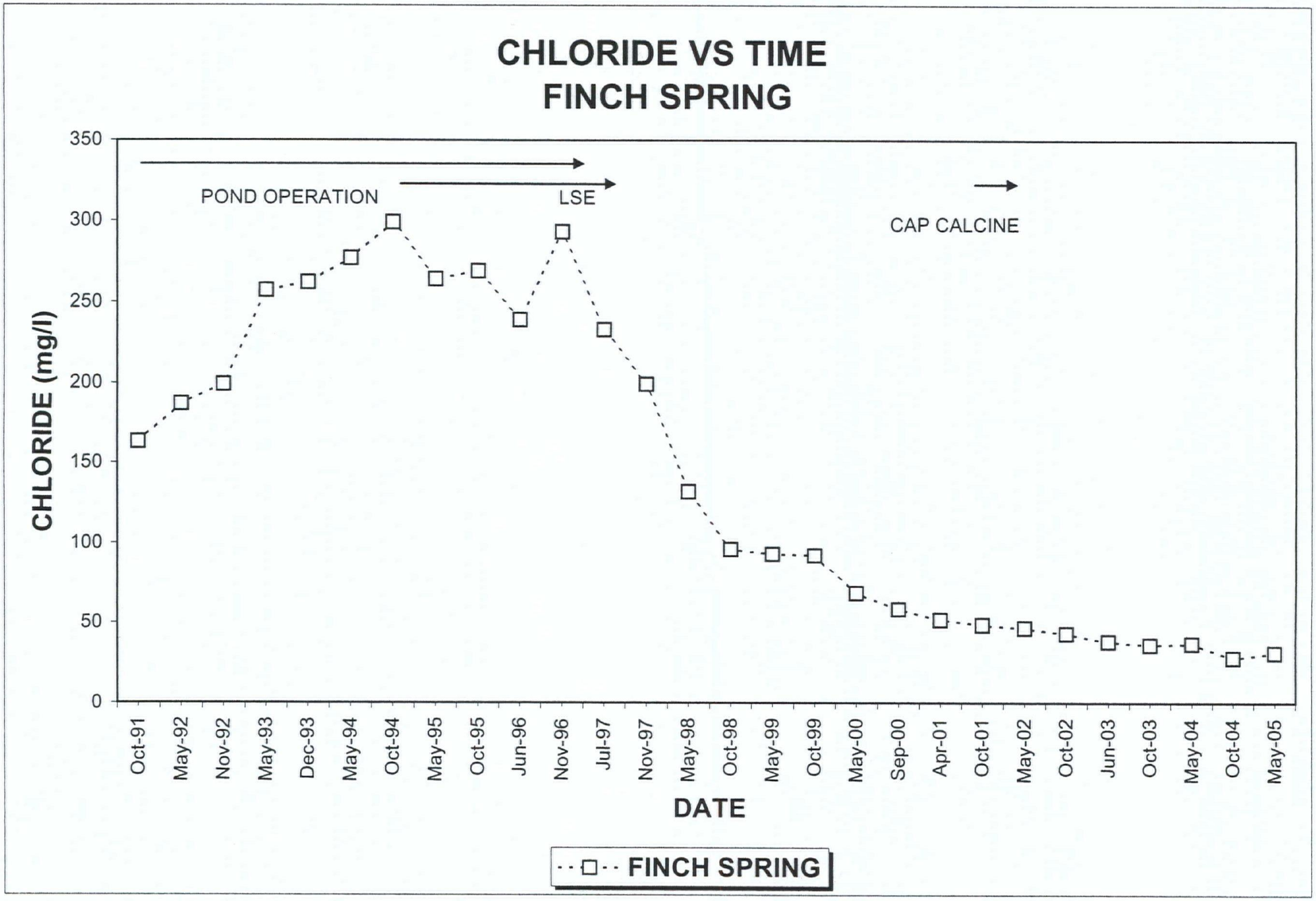
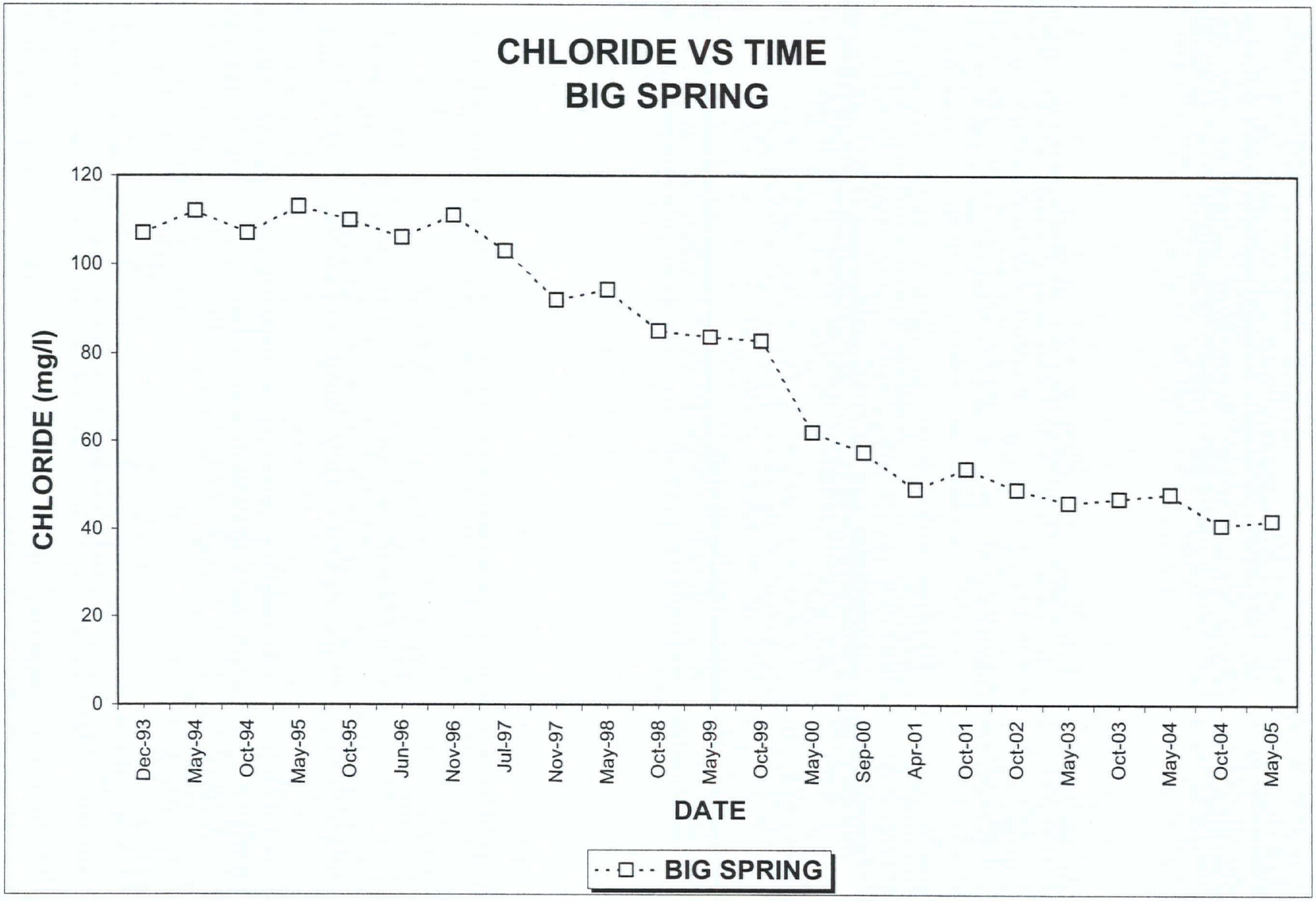
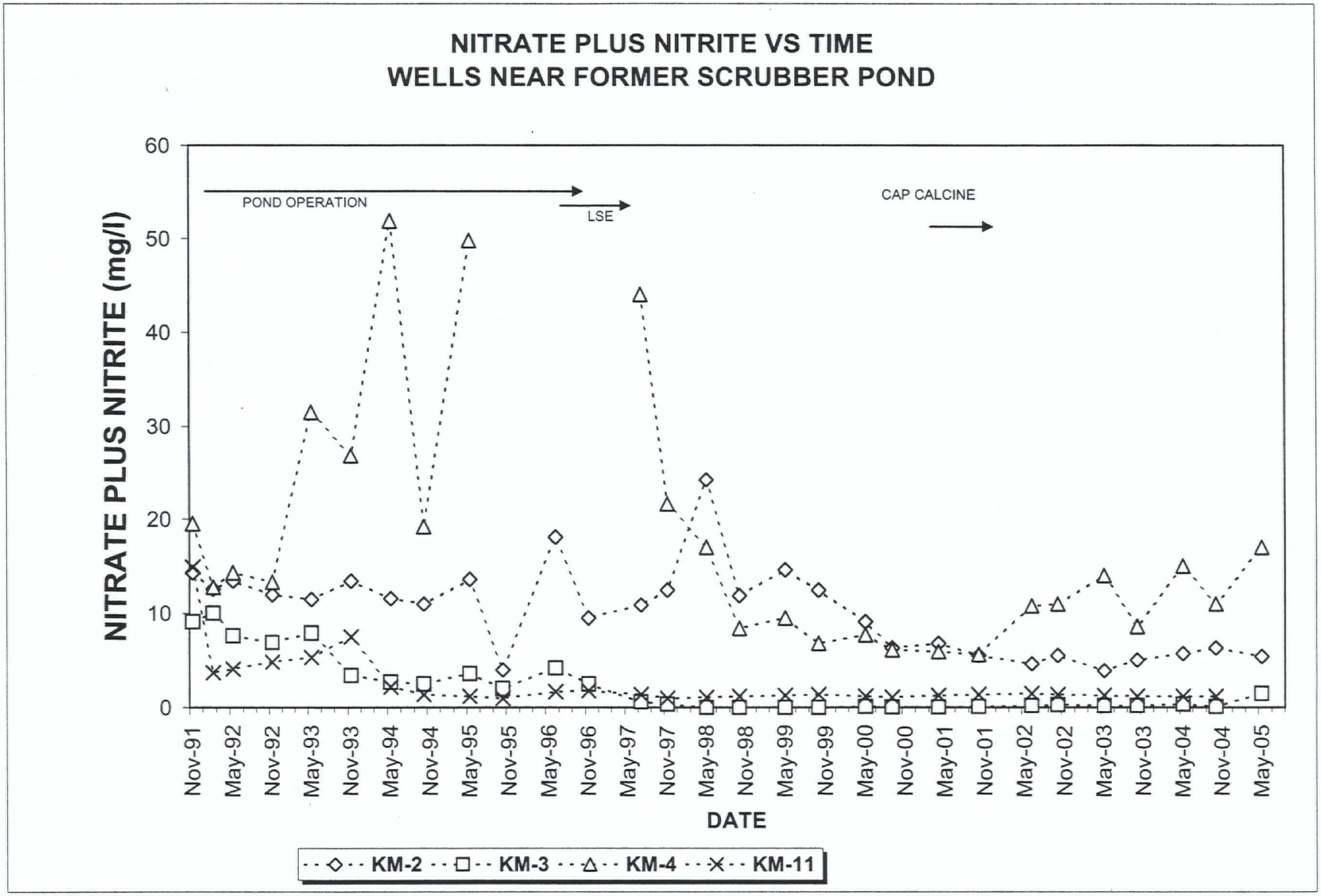
May-04
Oct-04
May-05
DATE
KM-15
KM-16
KM-17
KM-18


CHLORIDE VS TIME
FINCH SPRING
POND OPERATION
LSE
CAP CALCINE
CHLORIDE (mg/l)
350
300
250
200
150
100
50
0
Oct-91
May-92
Nov-92
May-93
Dec-93
May-94
Oct-94
May-95
Oct-95
Jun-96
Nov-96
Jul-97
Nov-97
May-98
Oct-98
May-99
Oct-99
May-00
Sep-00
Apr-01
Oct-01
May-02
Oct-02
Jun-03
Oct-03
May-04
Oct-04
May-05
DATE
FINCH SPRING


CHLORIDE VS TIME
BIG SPRING
CHLORIDE (mg/l)
0
20
40
60
80
100
120
Dec-93
May-94
Oct-94
May-95
Oct-95
Jun-96
Nov-96
Jul-97
Nov-97
May-98
Oct-98
May-99
Oct-99
May-00
Sep-00
Apr-01
Oct-01
Oct-02
May-03
Oct-03
May-04
Oct-04
May-05
DATE
BIG SPRING


NITRATE PLUS NITRITE VS TIME
WELLS NEAR FORMER SCRUBBER POND
NITRATE PLUS NITRITE (mg/l)
60
50
40
30
20
10
0
POND OPERATION
LSE
CAP CALCINE
Nov-91
May-92
Nov-92
May-93
Nov-93
May-94
Nov-94
May-95
Nov-95
May-96
Nov-96
May-97
Nov-97
May-98
Nov-98
May-99
Nov-99
May-00
Nov-00
May-01
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May-02
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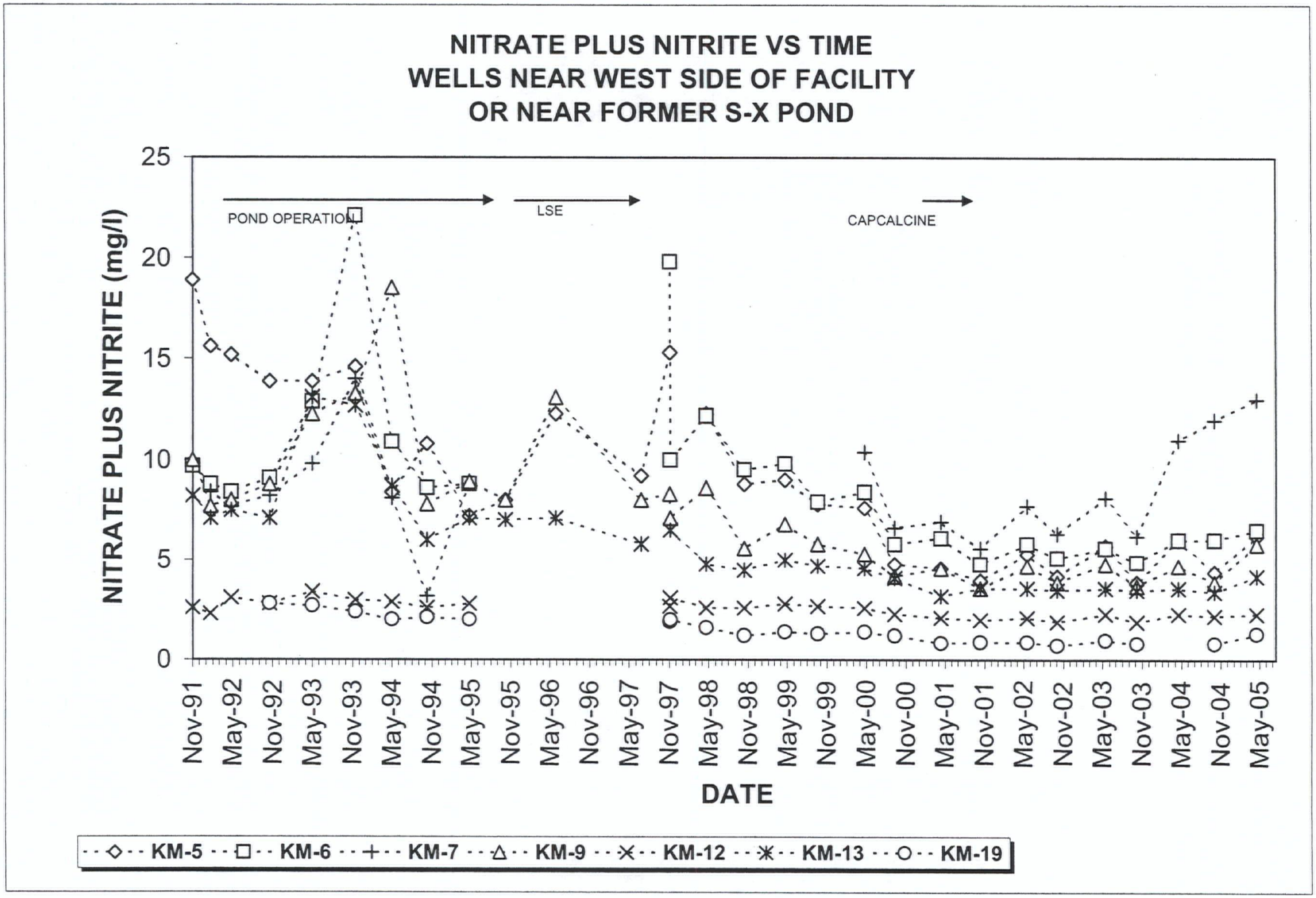
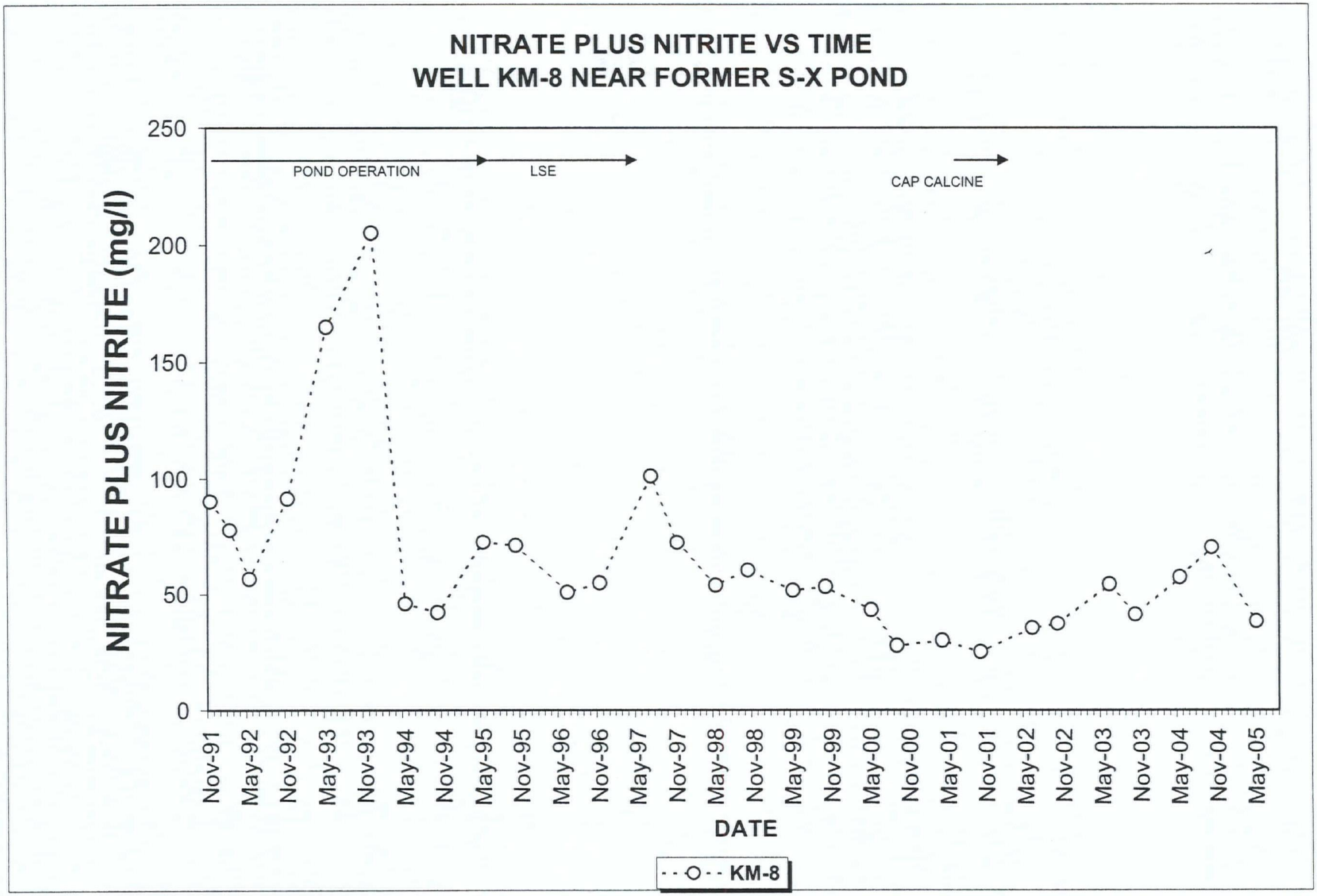
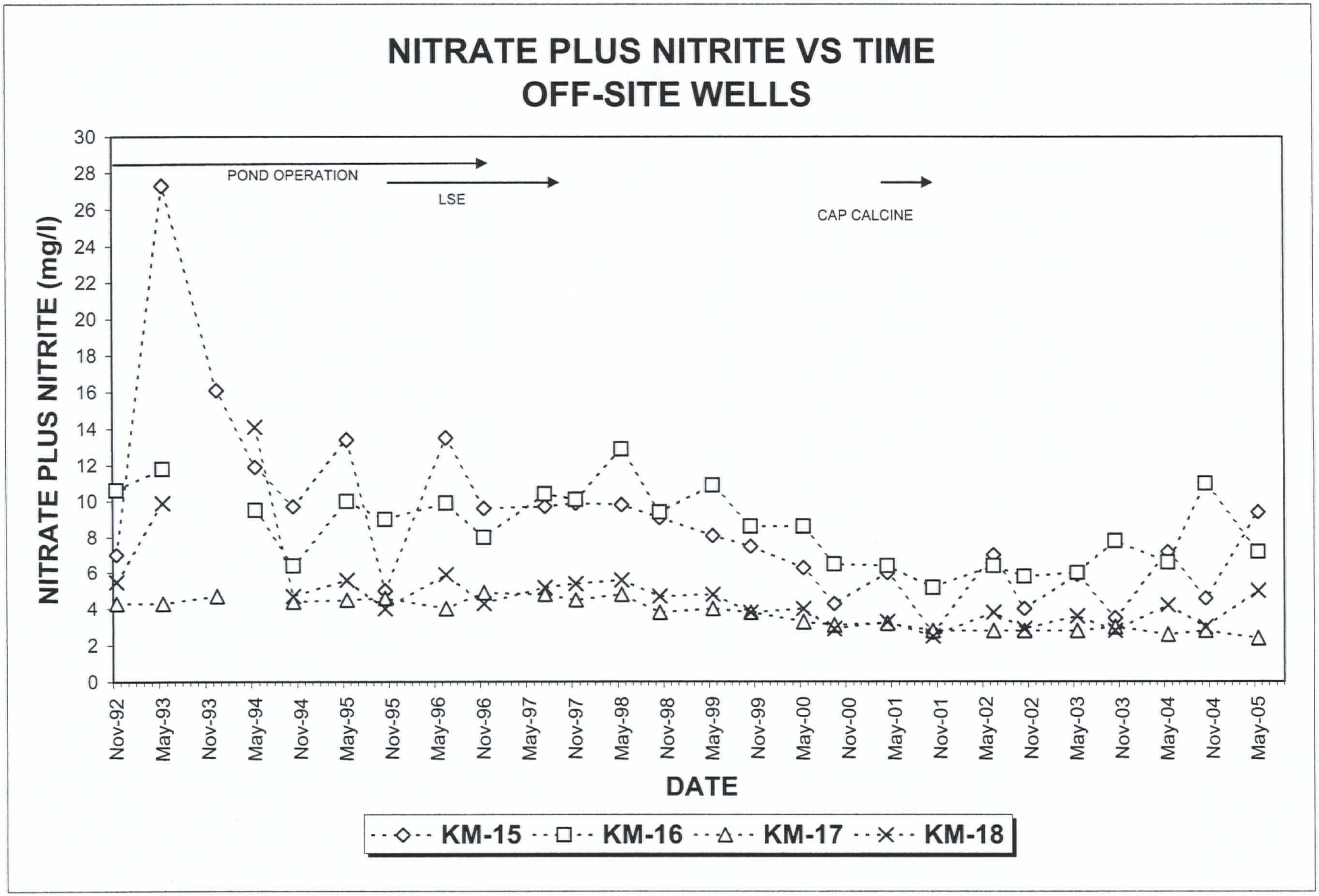
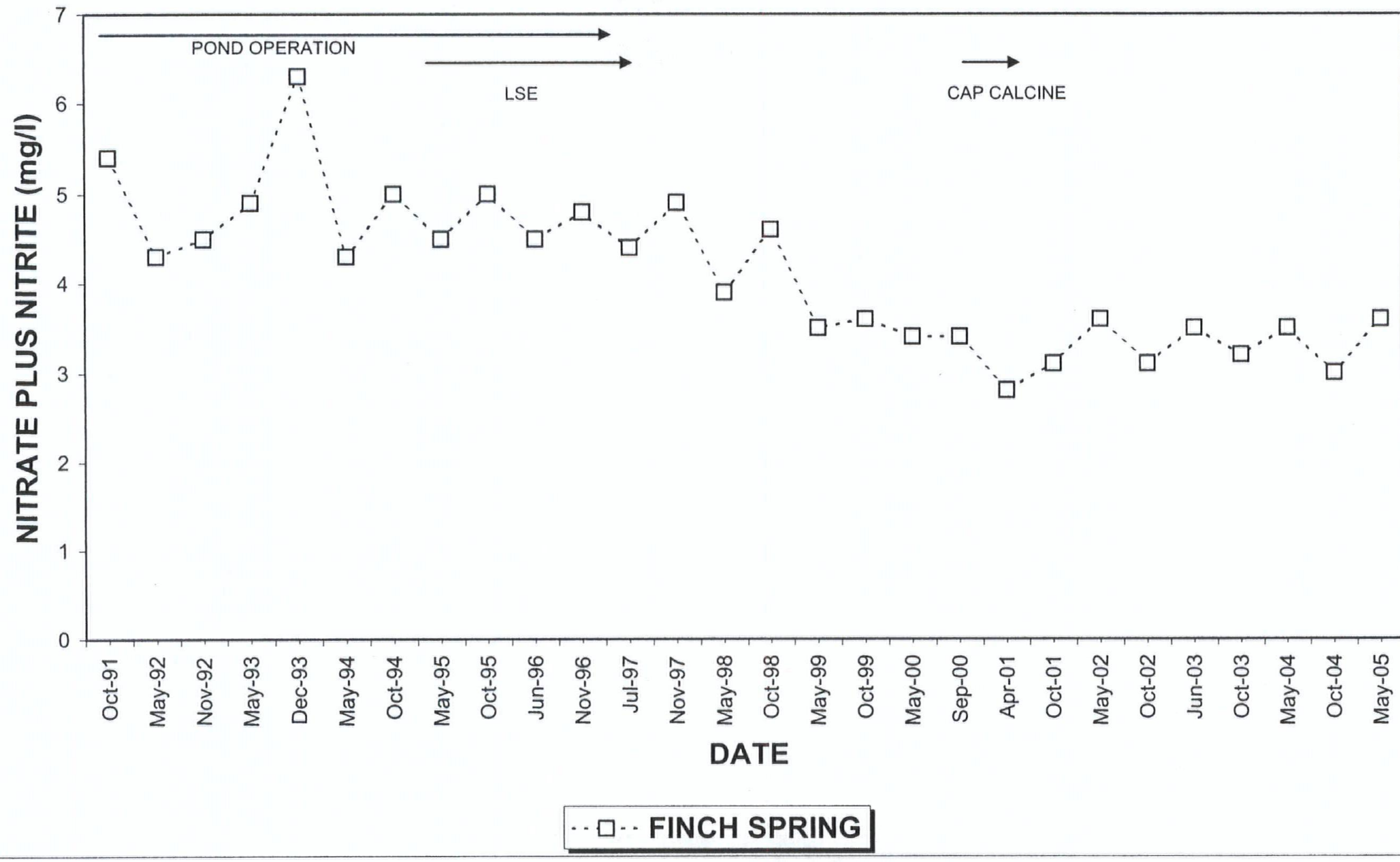
May-03
Nov-03
May-04
Nov-04
May-05
DATE
KM-2
KM-3
KM-4
KM-11

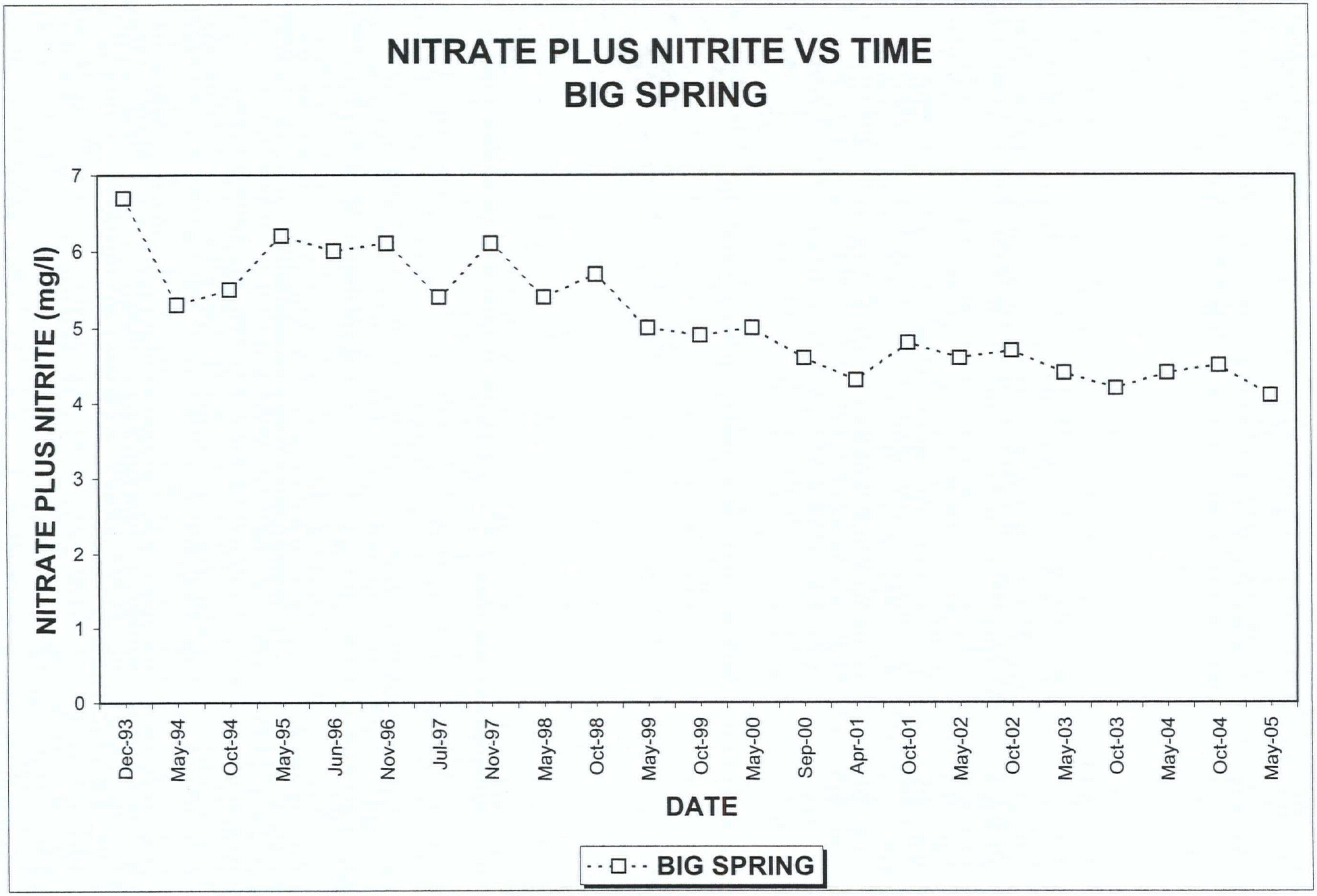

NITRATE PLUS NITRITE VS TIME
WELLS NEAR WEST SIDE OF FACILITY
OR NEAR FORMER S-X POND
NITRATE PLUS NITRITE (mg/l)
25
20
15
10
5
0
POND OPERATION
LSE
CAPCALCINE
Nov-91
May-92
Nov-92
May-93
Nov-93
May-94
Nov-94
May-95
Nov-95
May-96
Nov-96
May-97
Nov-97
May-98
Nov-98
May-99
Nov-99
May-00
Nov-00
May-01
Nov-01
May-02
Nov-02
May-03
Nov-03
May-04
Nov-04
May-05
DATE
KM-5
KM-6
KM-7
KM-9
KM-12
KM-13
KM-19

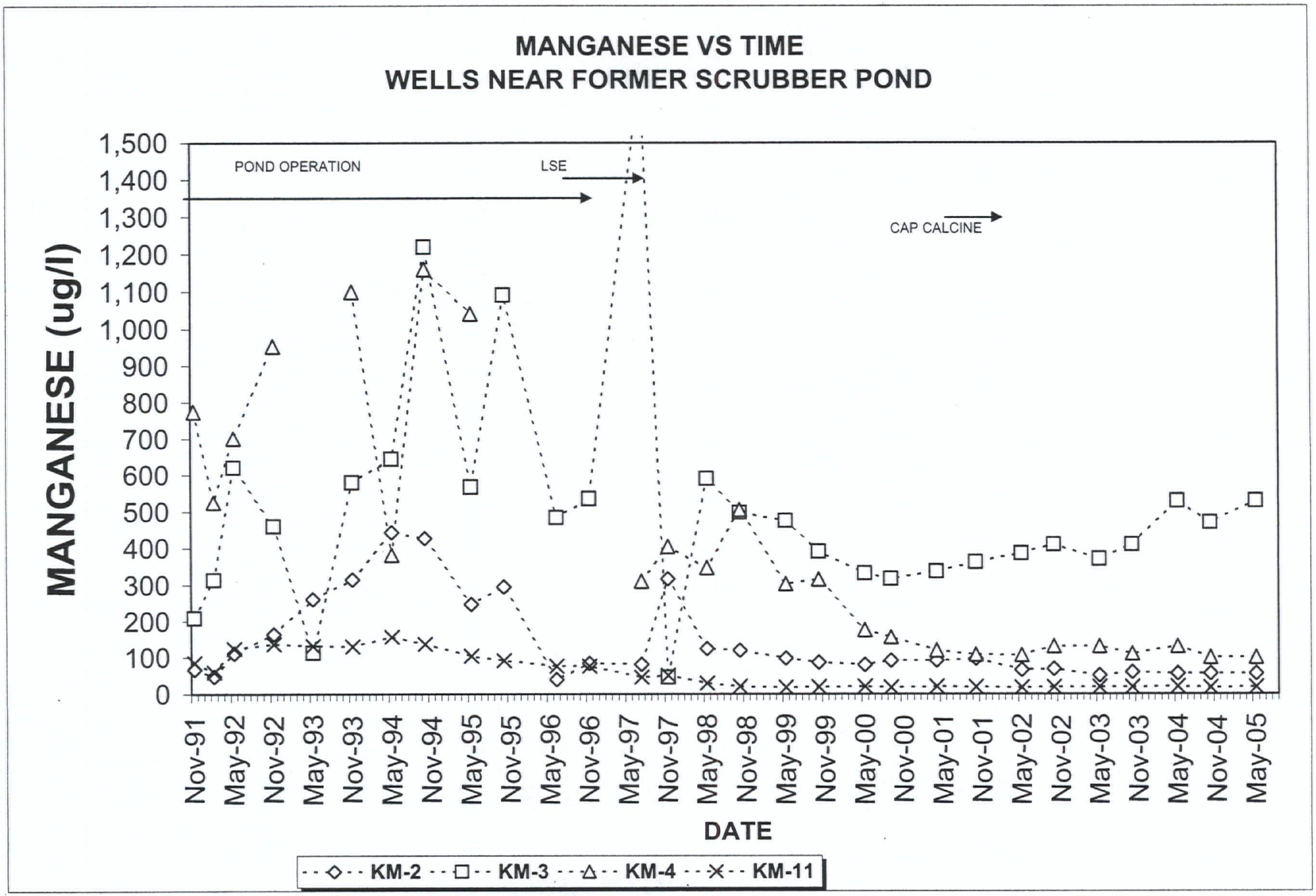

NITRATE PLUS NITRITE VS TIME
WELL KM-8 NEAR FORMER S-X POND
NITRATE PLUS NITRITE (mg/l)
0
50
100
150
200
250
POND OPERATION
LSE
CAP CALCINE
Nov-91
May-92
Nov-92
May-93
Nov-93
May-94
Nov-94
May-95
Nov-95
May-96
Nov-96
May-97
Nov-97
May-98
Nov-98
May-99
Nov-99
May-00
Nov-00
May-01
Nov-01
May-02
Nov-02
May-03
Nov-03
May-04
Nov-04
May-05
DATE
KM-8


NITRATE PLUS NITRITE VS TIME
OFF-SITE WELLS
POND OPERATION
LSE
CAP CALCINE
NITRATE PLUS NITRITE (mg/l)
0
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
Nov-92
May-93
Nov-93
May-94
Nov-94
May-95
Nov-95
May-96
Nov-96
May-97
Nov-97
May-98
Nov-98
May-99
Nov-99
May-00
Nov-00
May-01
Nov-01
May-02
Nov-02
May-03
Nov-03
May-04
Nov-04
May-05
DATE
KM-15
KM-16
KM-17
KM-18

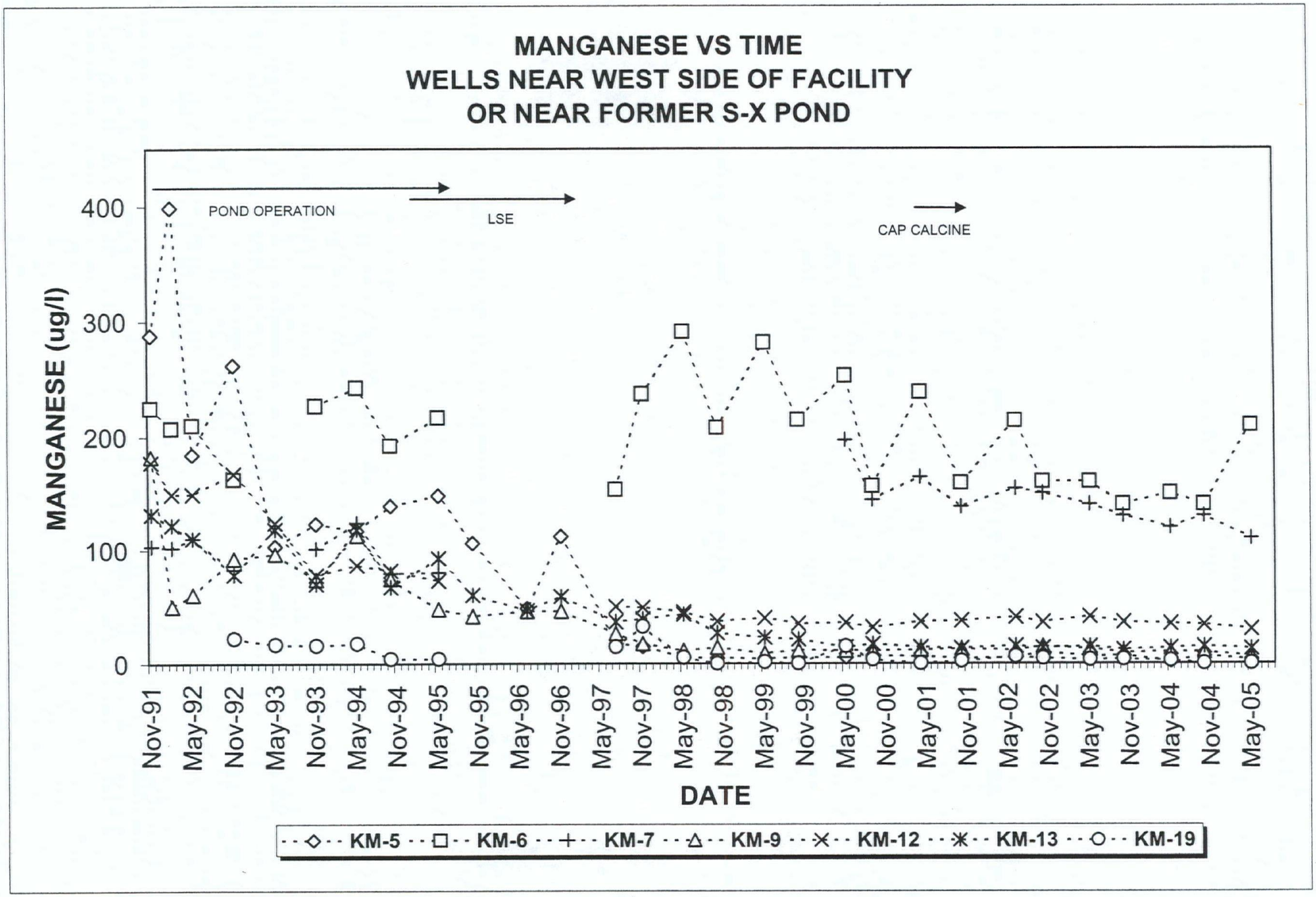
NITRATE PLUS NITRITE VS TIME
FINCH SPRING



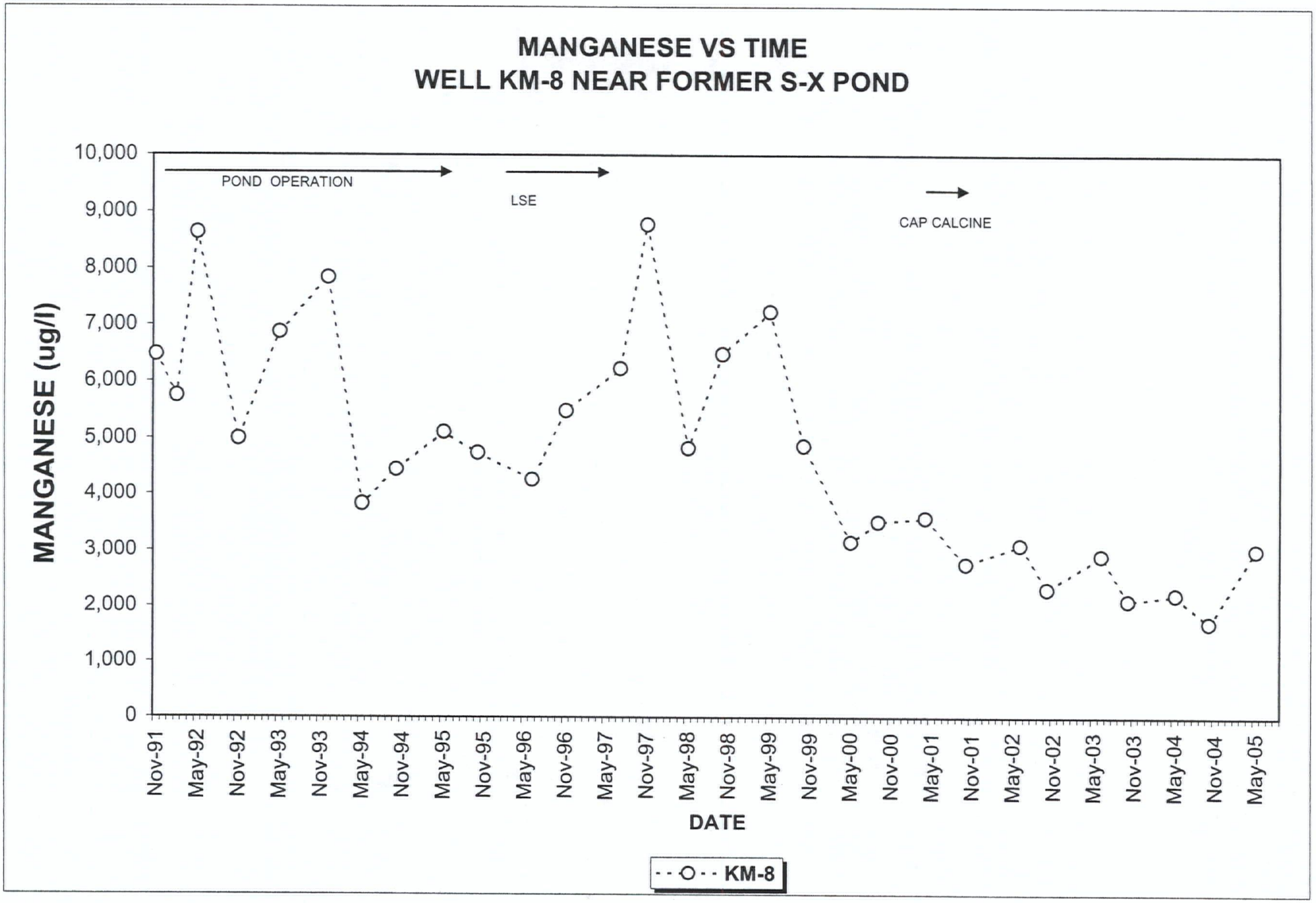

NITRATE PLUS NITRITE VS TIME
BIG SPRING
NITRATE PLUS NITRITE (mg/l)
0
1
2
3
4
5
6
7
Dec-93
May-94
Oct-94
May-95
Jun-96
Nov-96
Jul-97
Nov-97
May-98
Oct-98
May-99
Oct-99
May-00
Sep-00
Apr-01
Oct-01
May-02
Oct-02
May-03
Oct-03
May-04
Oct-04
May-05
DATE
BIG SPRING



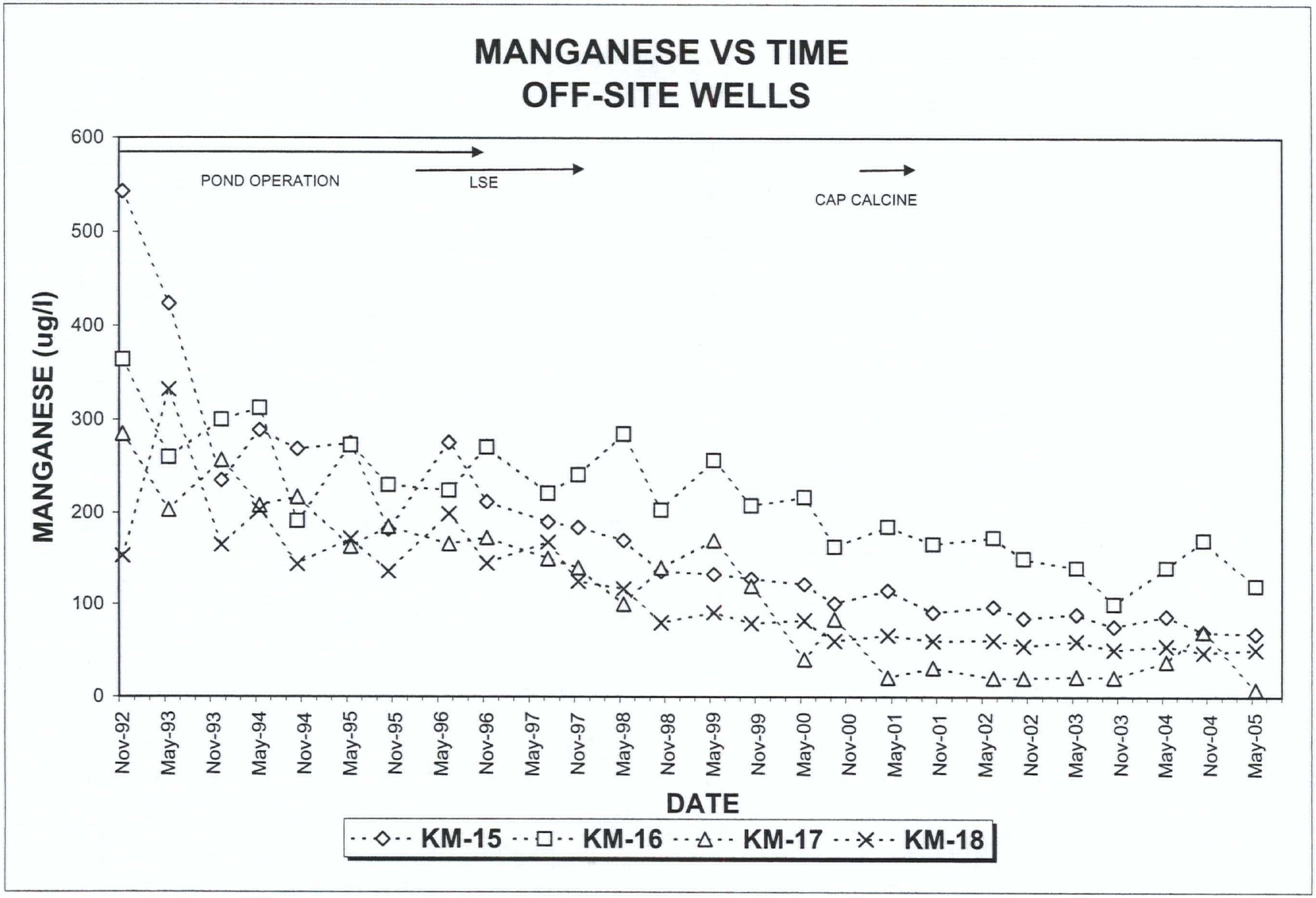
RBC FOR MANGANESE IS 180 ug/l
KM-2, KM-3, KM-11 ARE POC WELLS

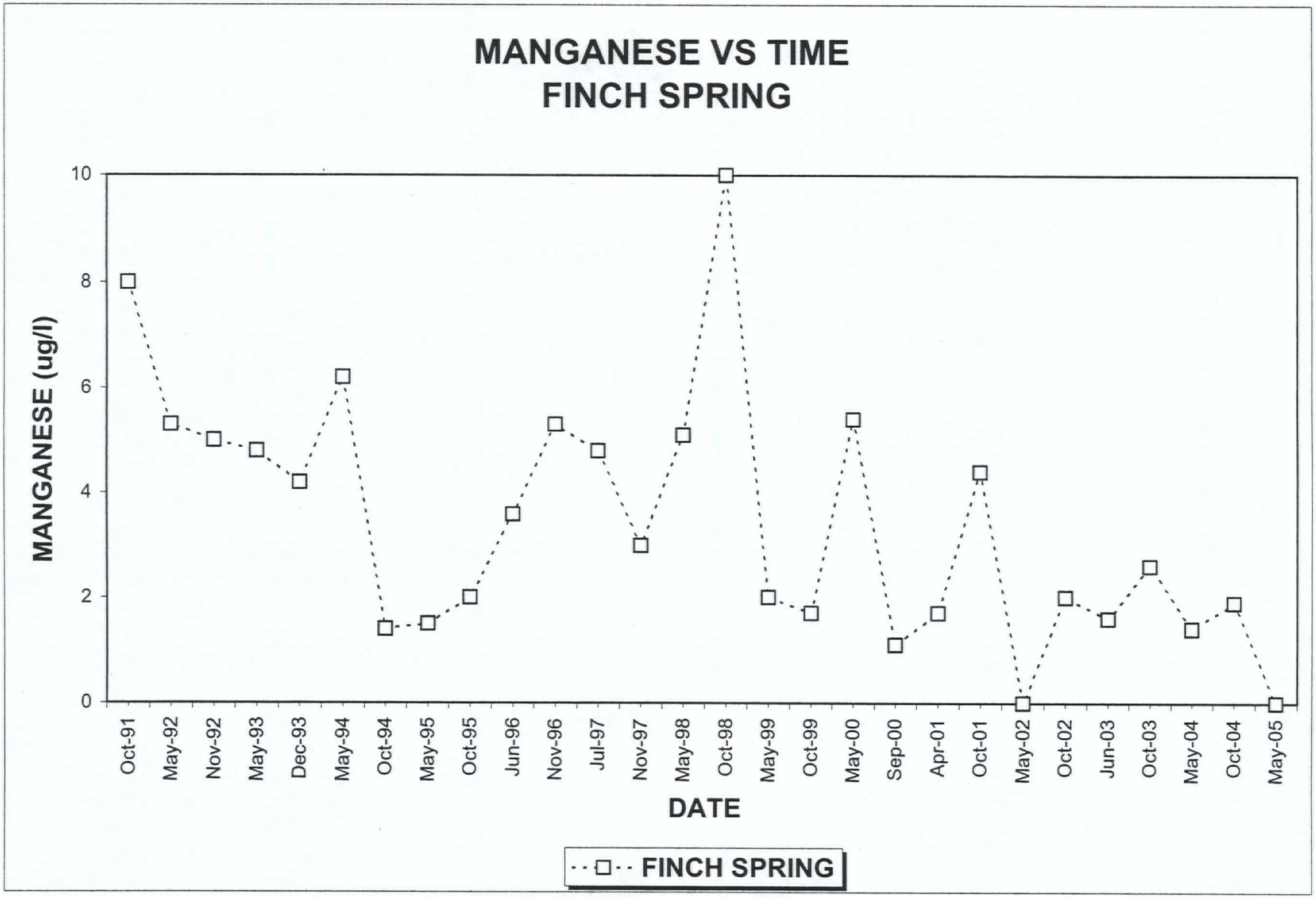


RBC FOR MANGANESE IS 180 ug/l
KM-5, KM-9, KM-12, KM-13, KM-19 ARE POC WELLS

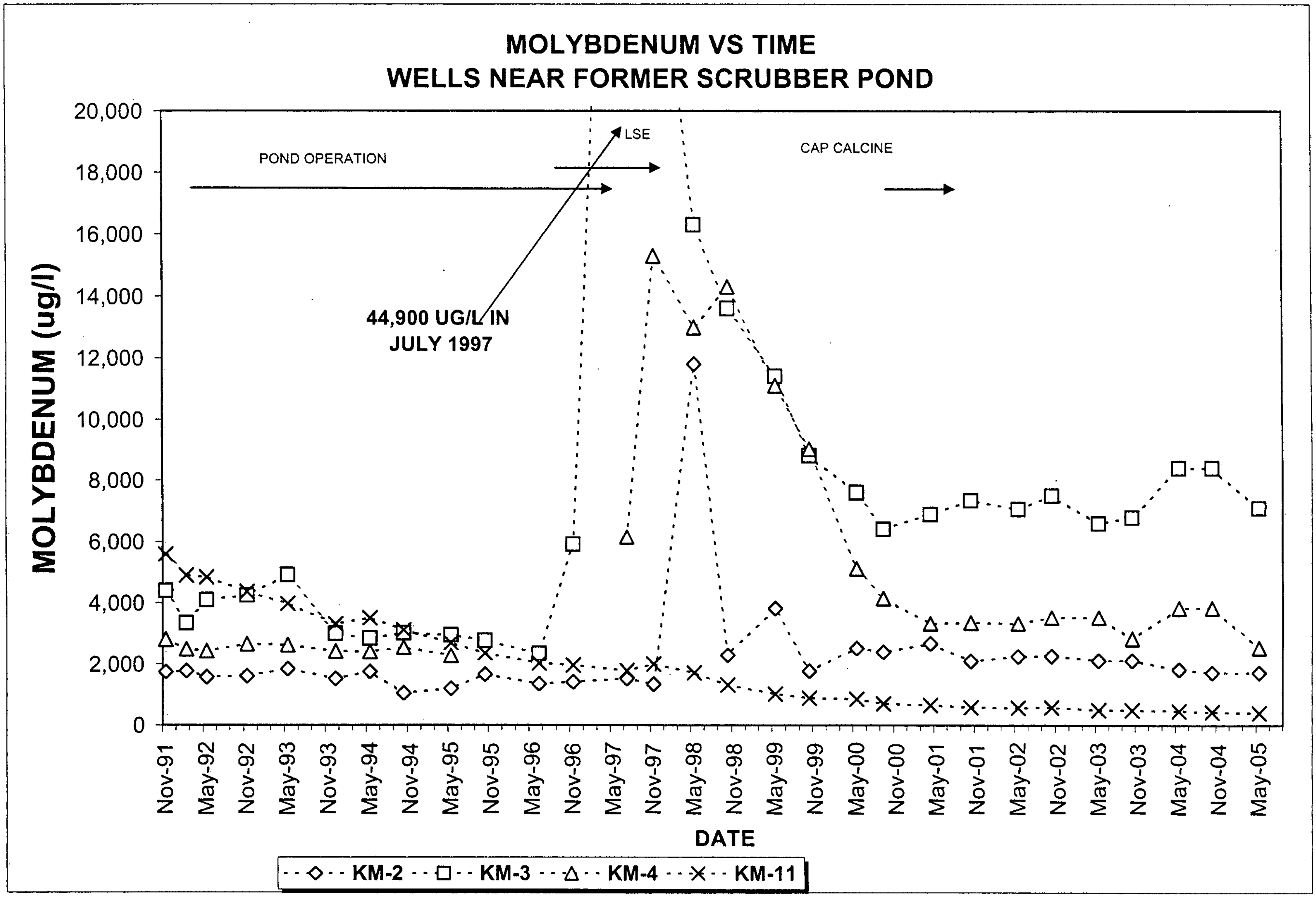


RBC FOR MANGANESE IS 180 ug/l
KM-8 IS A POC WELL

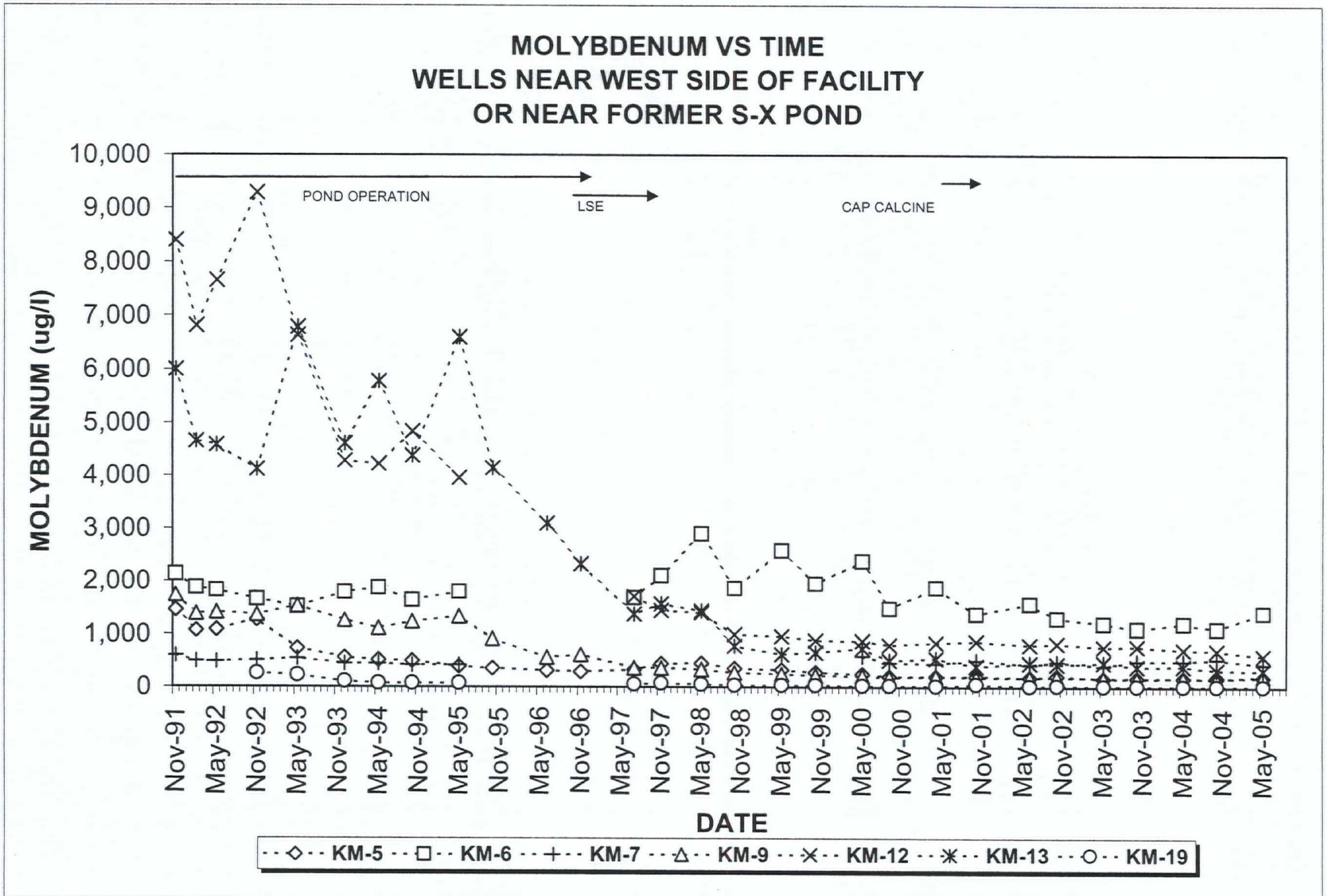

MANGANESE VS TIME
OFF-SITE WELLS
POND OPERATION
LSE
CAP CALCINE
MANGANESE (ug/l)
0
100
200
300
400
500
600
Nov-92
May-93
Nov-93
May-94
Nov-94
May-95
Nov-95
May-96
Nov-96
May-97
Nov-97
May-98
Nov-98
May-99
Nov-99
May-00
Nov-00
May-01
Nov-01
May-02
Nov-02
May-03
Nov-03
May-04
Nov-04
May-05
DATE
KM-15
KM-16
KM-17
KM-18



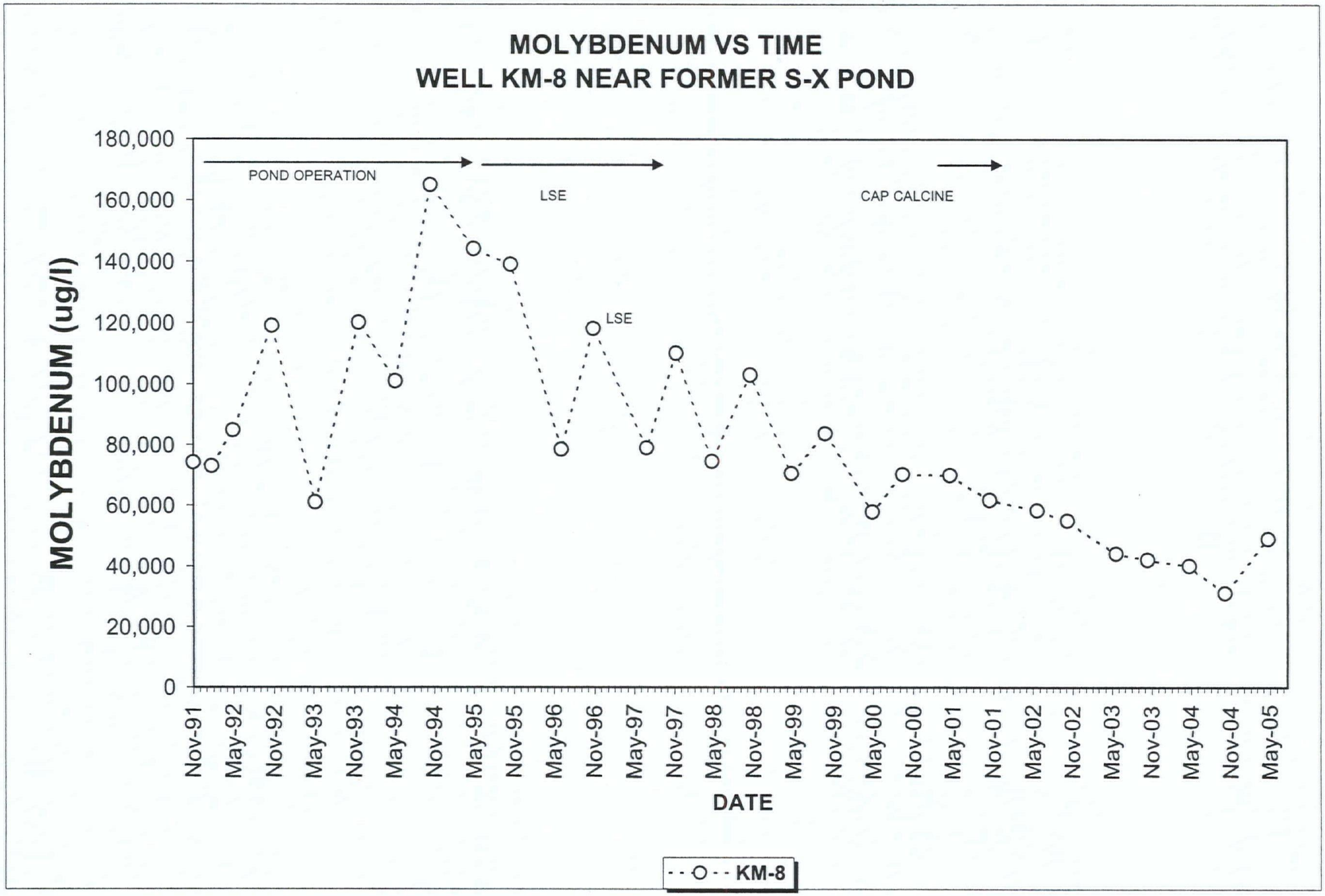
Values less than detection plotted at the detection limit
October 1998 sample less than detection



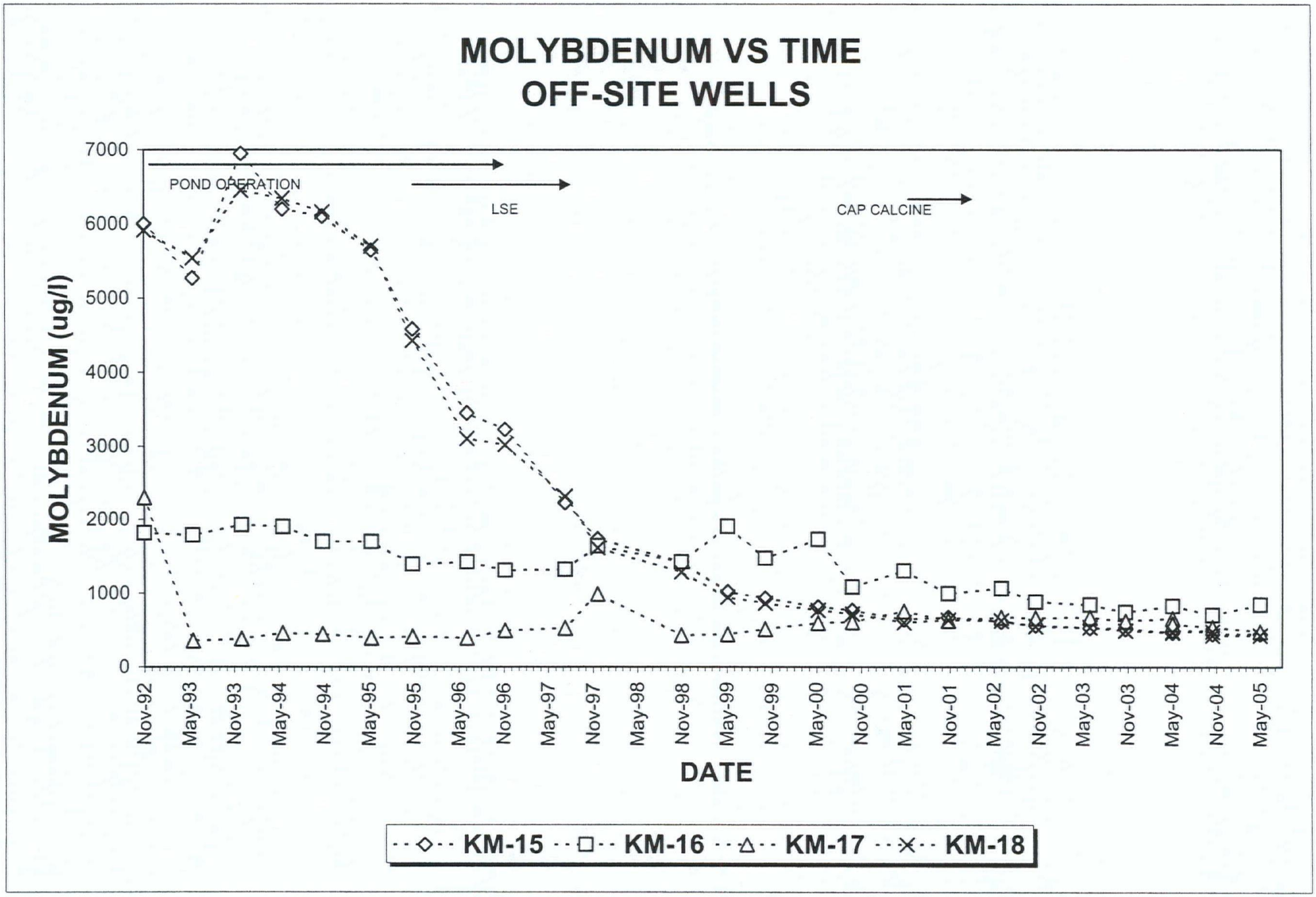
RBC FOR MOLYBDENUM IS 180 ug/l
KM-2, KM-3, KM-11 ARE POC WELLS



RBC FOR MOLYBDENUM IS 180 ug/l
KM-5, KM-9, KM-12, KM-13, KM-19 ARE POC WELLS



RBC FOR MOLYBDENUM IS 180 ug/l
KM-8 IS A POC WELL


MOLYBDENUM VS TIME
OFF-SITE WELLS
MOLYBDENUM (ug/l)
7000
6000
5000
4000
3000
2000
1000
0
POND OPERATION
LSE
CAP CALCINE
Nov-92
May-93
Nov-93
May-94
Nov-94
May-95
Nov-95
May-96
Nov-96
May-97
Nov-97
May-98
Nov-98
May-99
Nov-99
May-00
Nov-00
May-01
Nov-01
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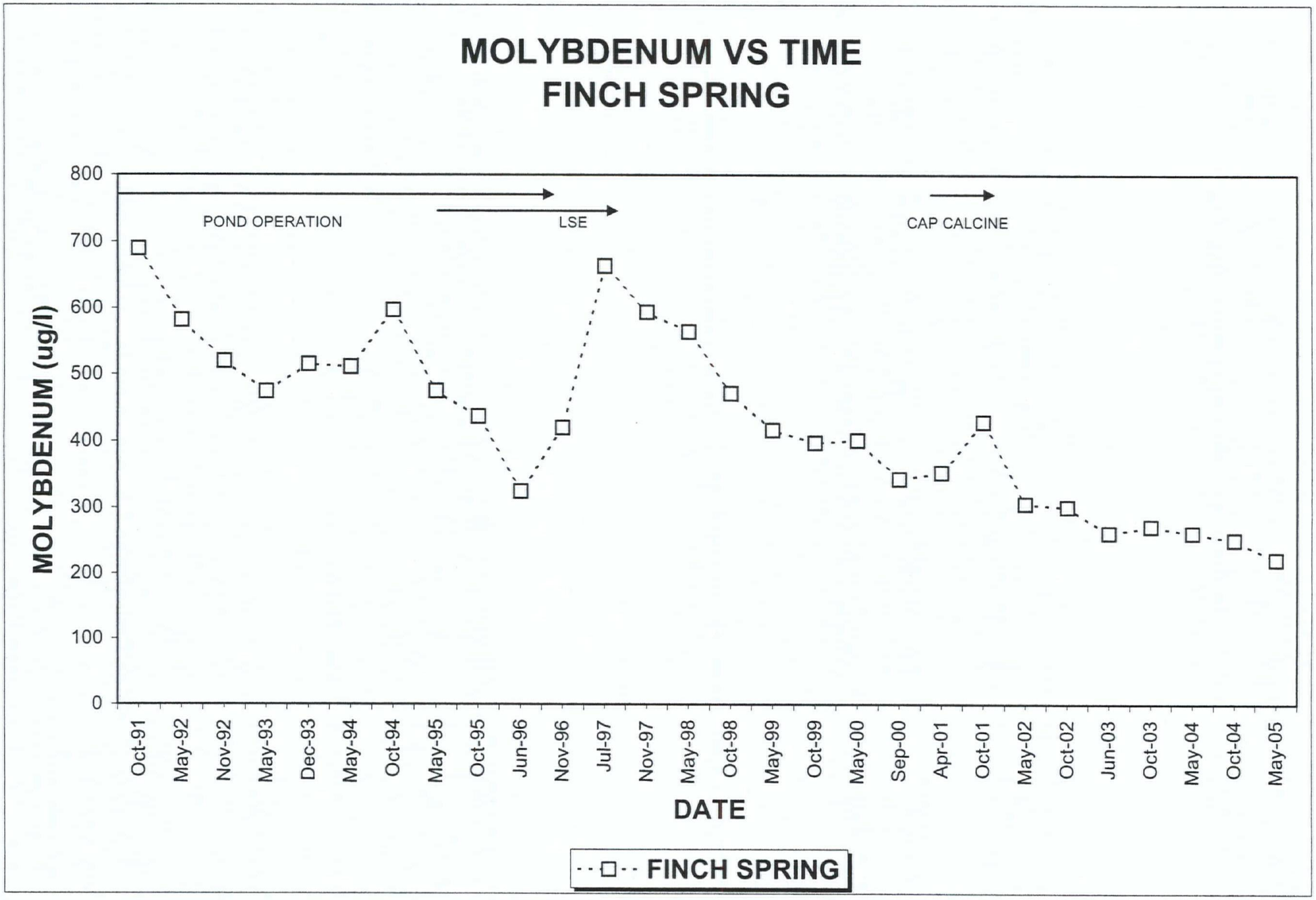
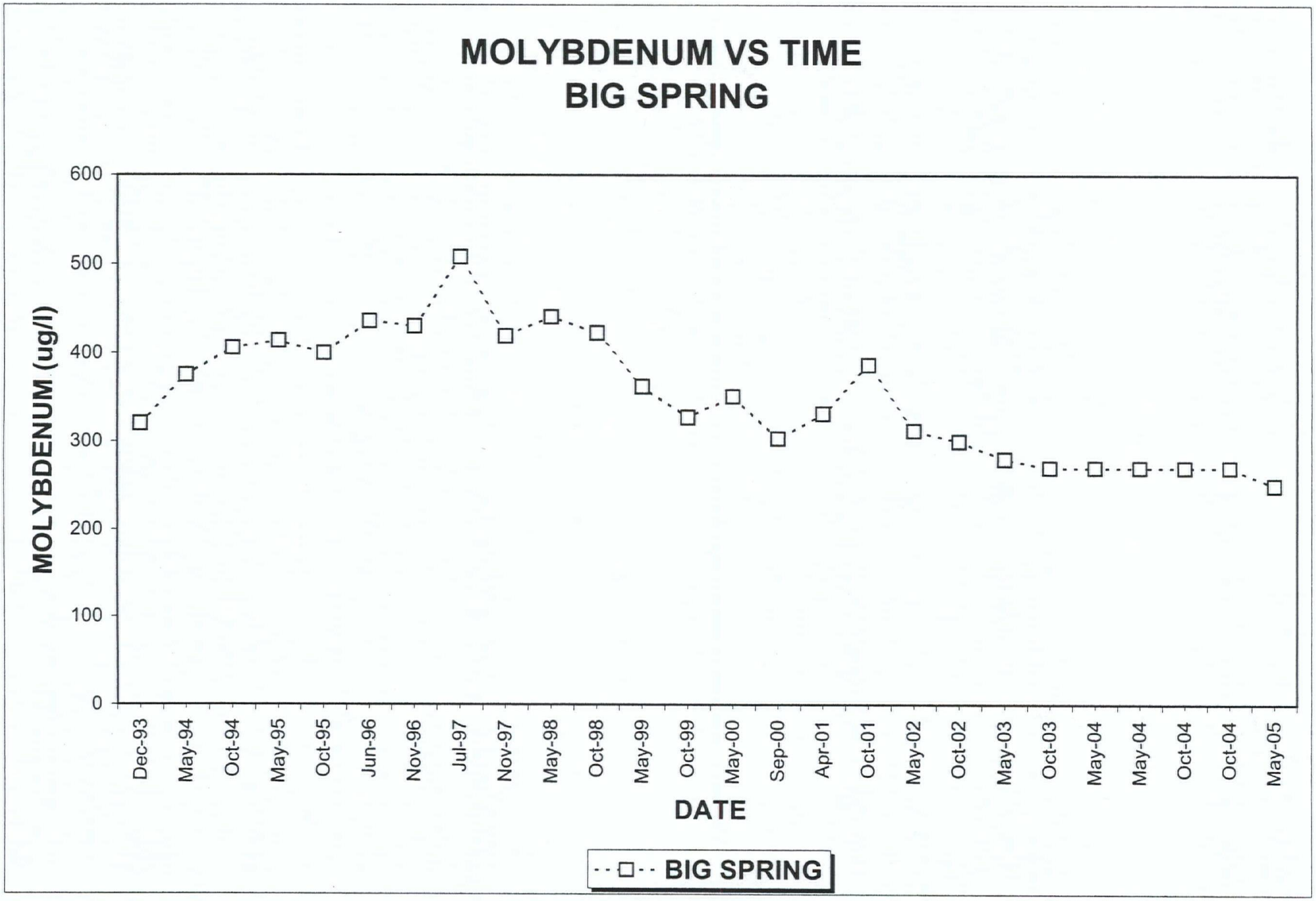
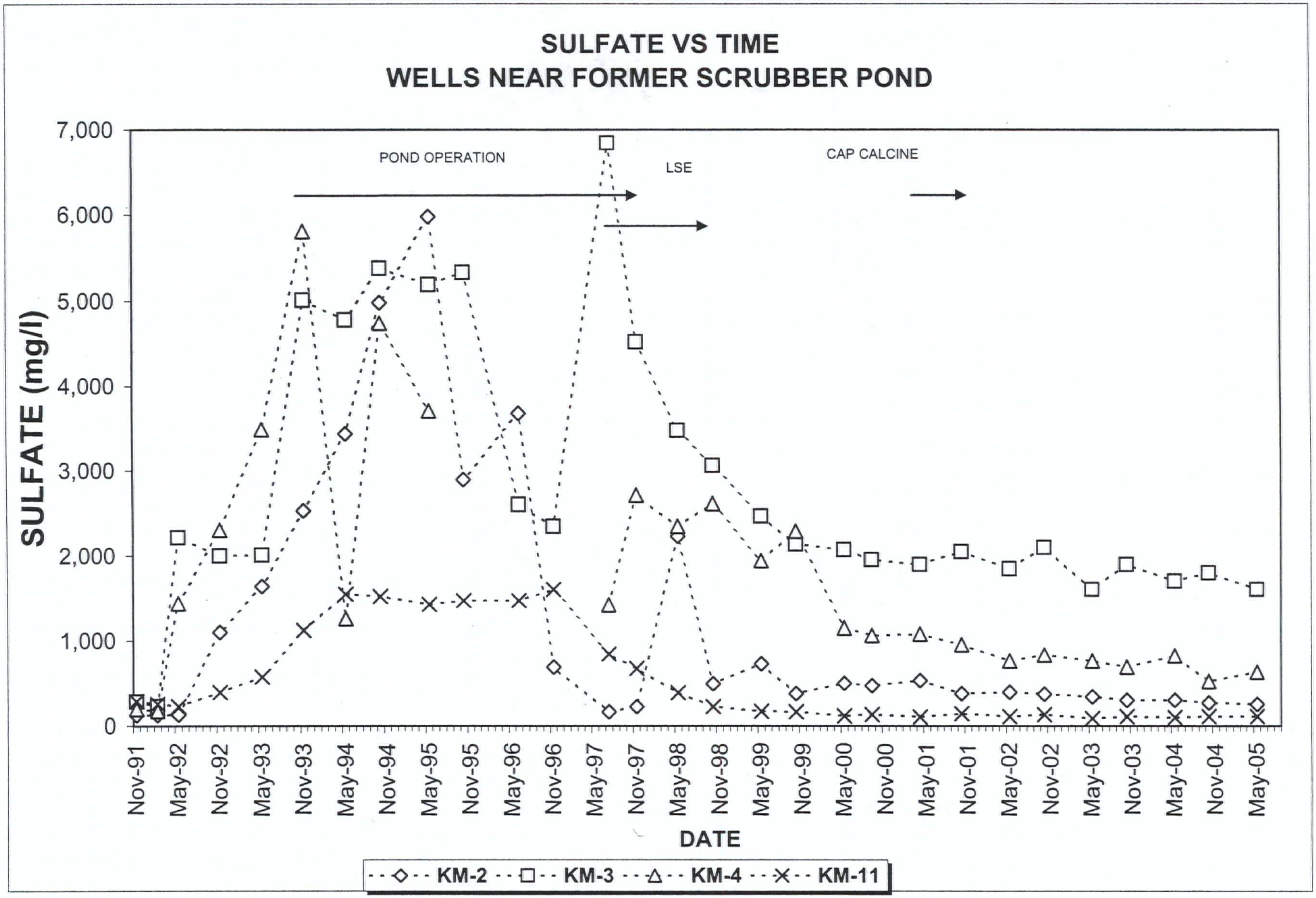
May-04
Nov-04
May-05
DATE
KM-15
KM-16
KM-17
KM-18


MOLYBDENUM VS TIME
FINCH SPRING
MOLYBDENUM (ug/l)
0
100
200
300
400
500
600
700
800
POND OPERATION
LSE
CAP CALCINE
Oct-91
May-92
Nov-92
May-93
Dec-93
May-94
Oct-94
May-95
Oct-95
Jun-96
Nov-96
Jul-97
Nov-97
May-98
Oct-98
May-99
Oct-99
May-00
Sep-00
Apr-01
Oct-01
May-02
Oct-02
Jun-03
Oct-03
May-04
Oct-04
May-05
DATE
FINCH SPRING


MOLYBDENUM VS TIME
BIG SPRING
MOLYBDENUM (ug/l)
600
500
400
300
200
100
0
Dec-93
May-94
Oct-94
May-95
Oct-95
Jun-96
Nov-96
Jul-97
Nov-97
May-98
Oct-98
May-99
Oct-99
May-00
Sep-00
Apr-01
Oct-01
May-02
Oct-02
May-03
Oct-03
May-04
May-04
Oct-04
Oct-04
May-05
DATE
BIG SPRING


SULFATE VS TIME
WELLS NEAR FORMER SCRUBBER POND
SULFATE (mg/l)
7,000
6,000
5,000
4,000
3,000
2,000
1,000
0
POND OPERATION
LSE
CAP CALCINE
Nov-91
May-92
Nov-92
May-93
Nov-93
May-94
Nov-94
May-95
Nov-95
May-96
Nov-96
May-97
Nov-97
May-98
Nov-98
May-99
Nov-99
May-00
Nov-00
May-01
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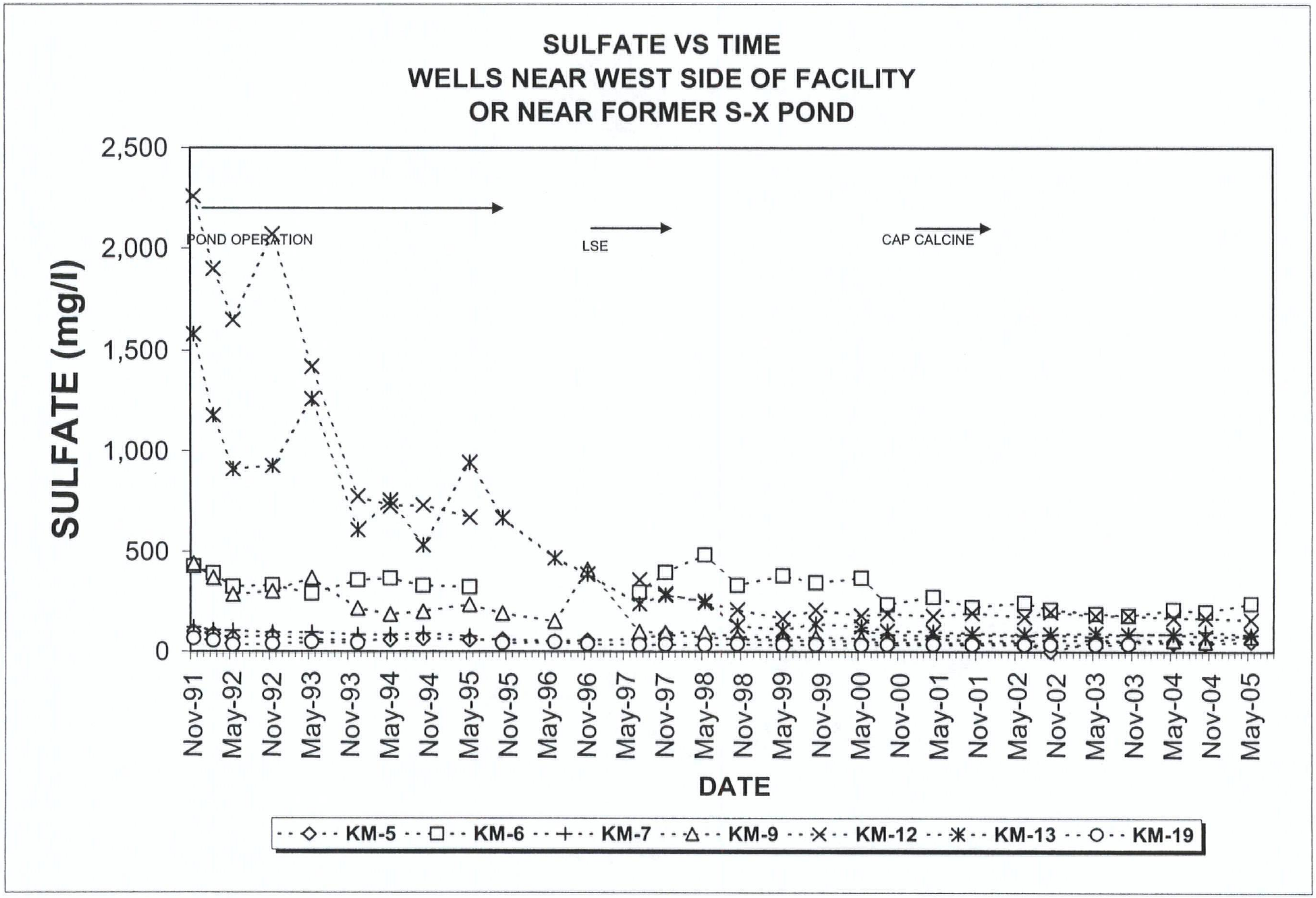
May-04
Nov-04
May-05
DATE
KM-2
KM-3
KM-4
KM-11


SULFATE VS TIME
WELLS NEAR WEST SIDE OF FACILITY
OR NEAR FORMER S-X POND
SULFATE (mg/l)
2,500
2,000
1,500
1,000
500
0
POND OPERATION
LSE
CAP CALCINE
Nov-91
May-92
Nov-92
May-93
Nov-93
May-94
Nov-94
May-95
Nov-95
May-96
Nov-96
May-97
Nov-97
May-98
Nov-98
May-99
Nov-99
May-00
Nov-00
May-01
Nov-01
May-02
Nov-02
May-03
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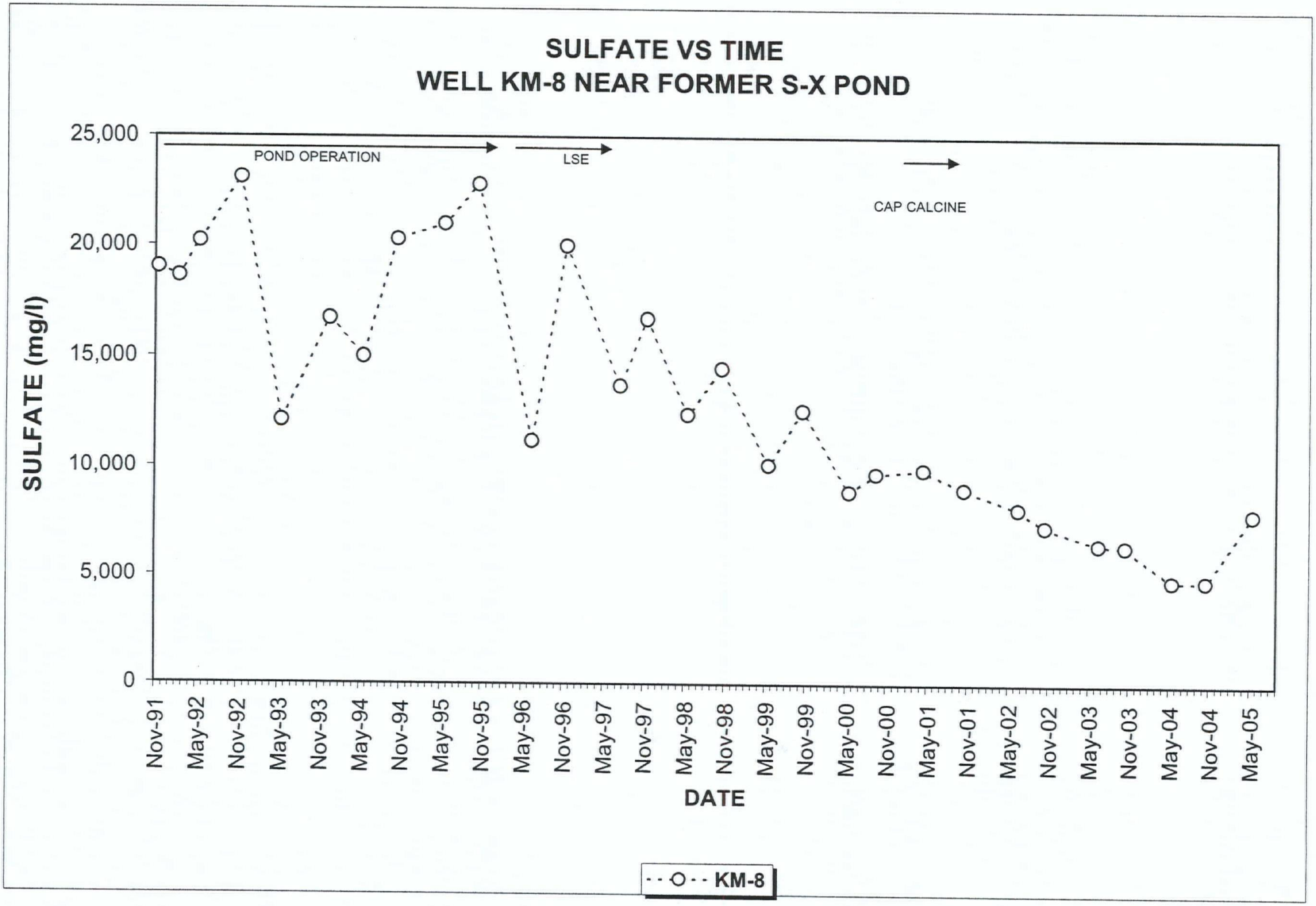
May-05
DATE
KM-5
KM-6
KM-7
KM-9
KM-12
KM-13
KM-19


SULFATE VS TIME
WELL KM-8 NEAR FORMER S-X POND
POND OPERATION
LSE
CAP CALCINE
SULFATE (mg/l)
25,000
20,000
15,000
10,000
5,000
0
Nov-91
May-92
Nov-92
May-93
Nov-93
May-94
Nov-94
May-95
Nov-95
May-96
Nov-96
May-97
Nov-97
May-98
Nov-98
May-99
Nov-99
May-00
Nov-00
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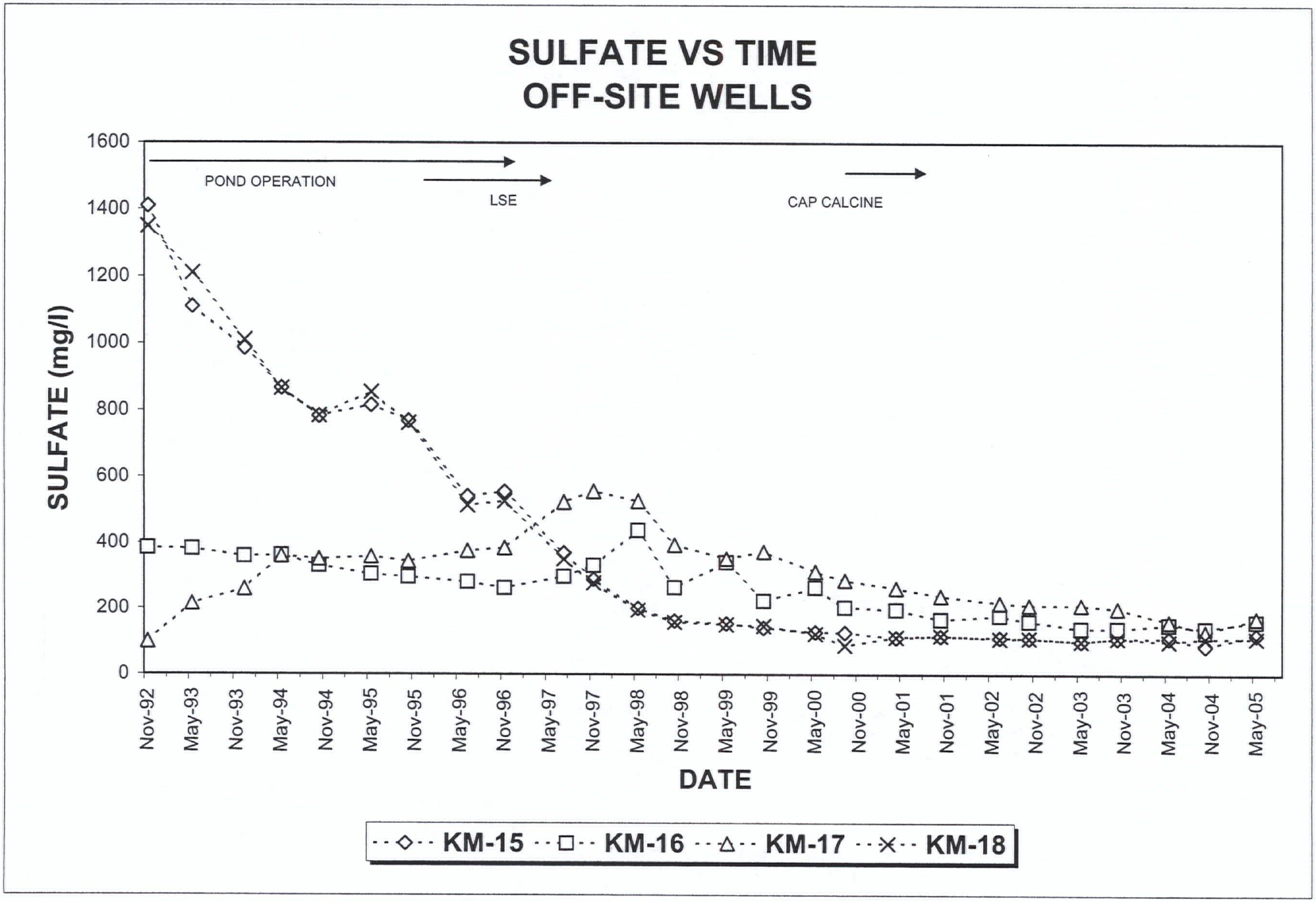
Nov-01
May-02
Nov-02
May-03
Nov-03
May-04
Nov-04
May-05
DATE
KM-8


SULFATE VS TIME
OFF-SITE WELLS
SULFATE (mg/l)
1600
1400
1200
1000
800
600
400
200
0
POND OPERATION
LSE
CAP CALCINE
Nov-92
May-93
Nov-93
May-94
Nov-94
May-95
Nov-95
May-96
Nov-96
May-97
Nov-97
May-98
Nov-98
May-99
Nov-99
May-00
Nov-00
May-01
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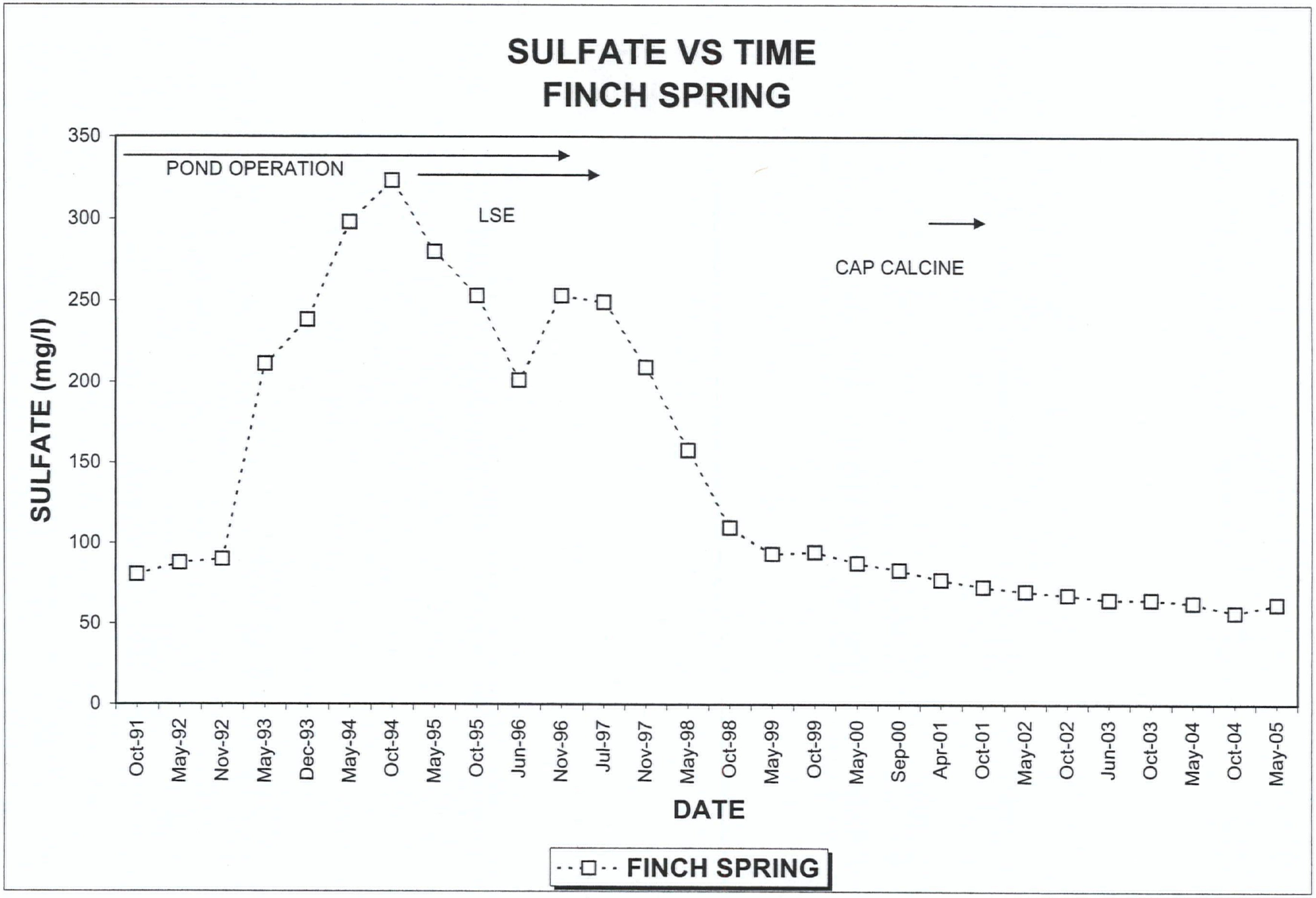
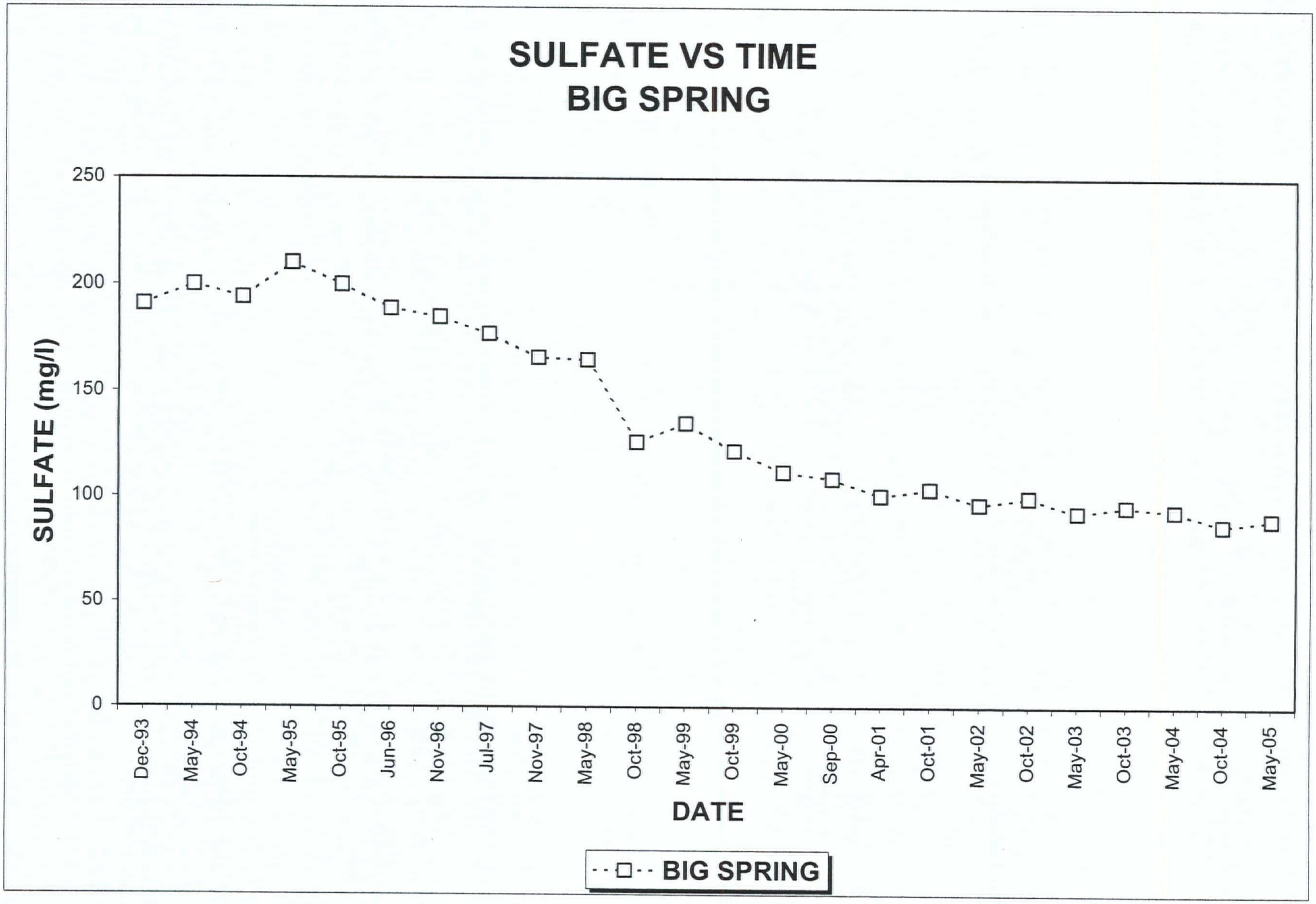
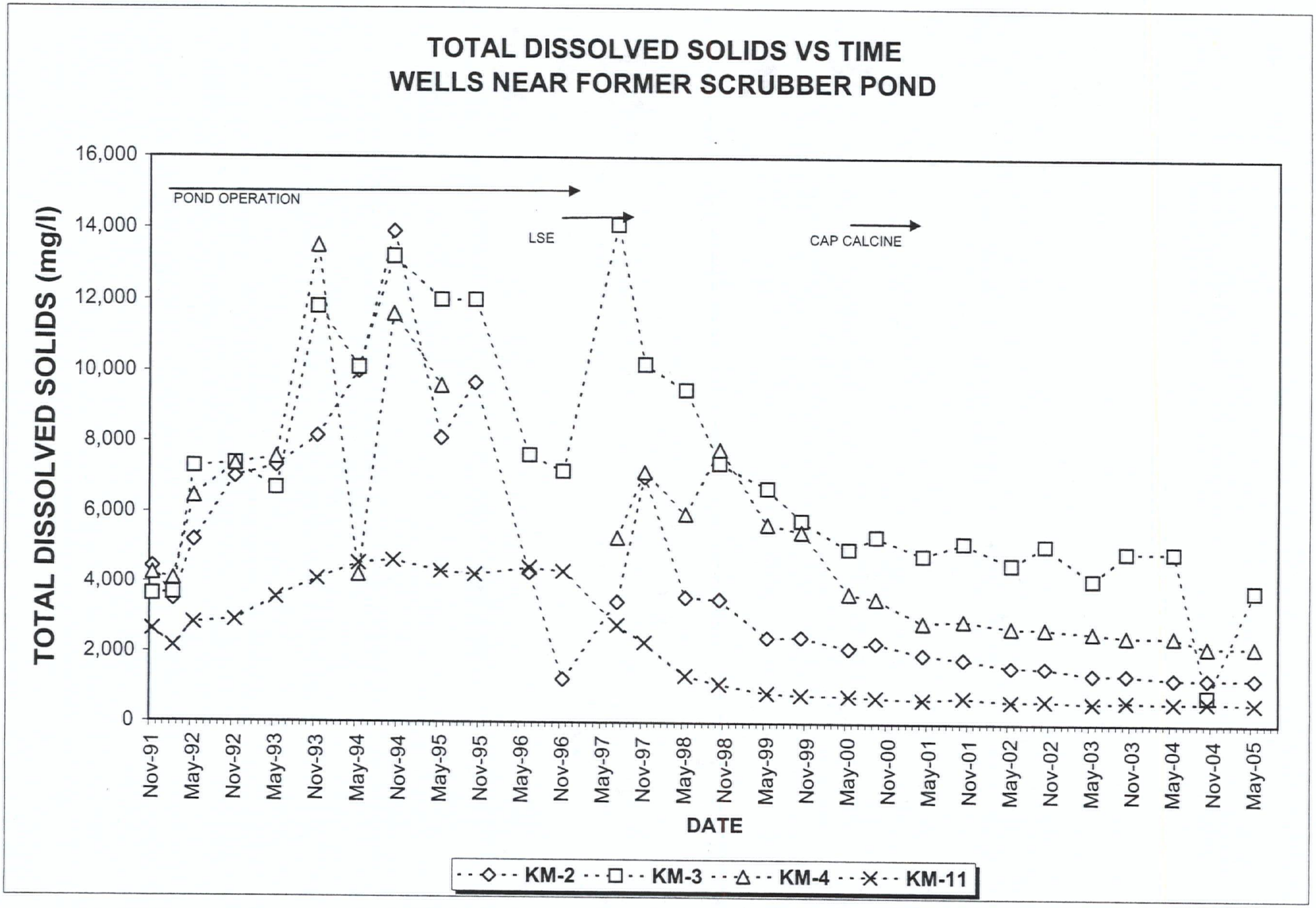
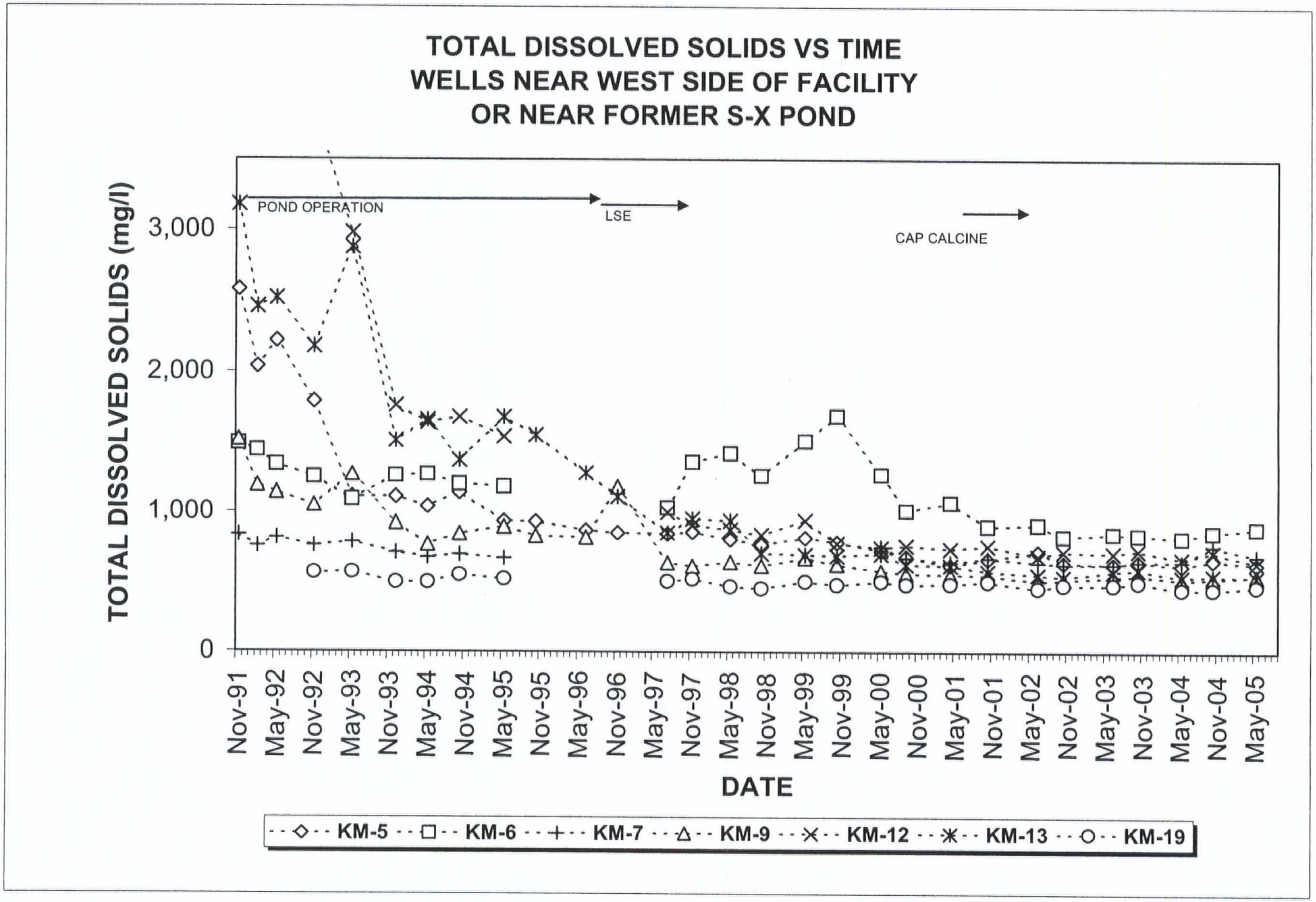
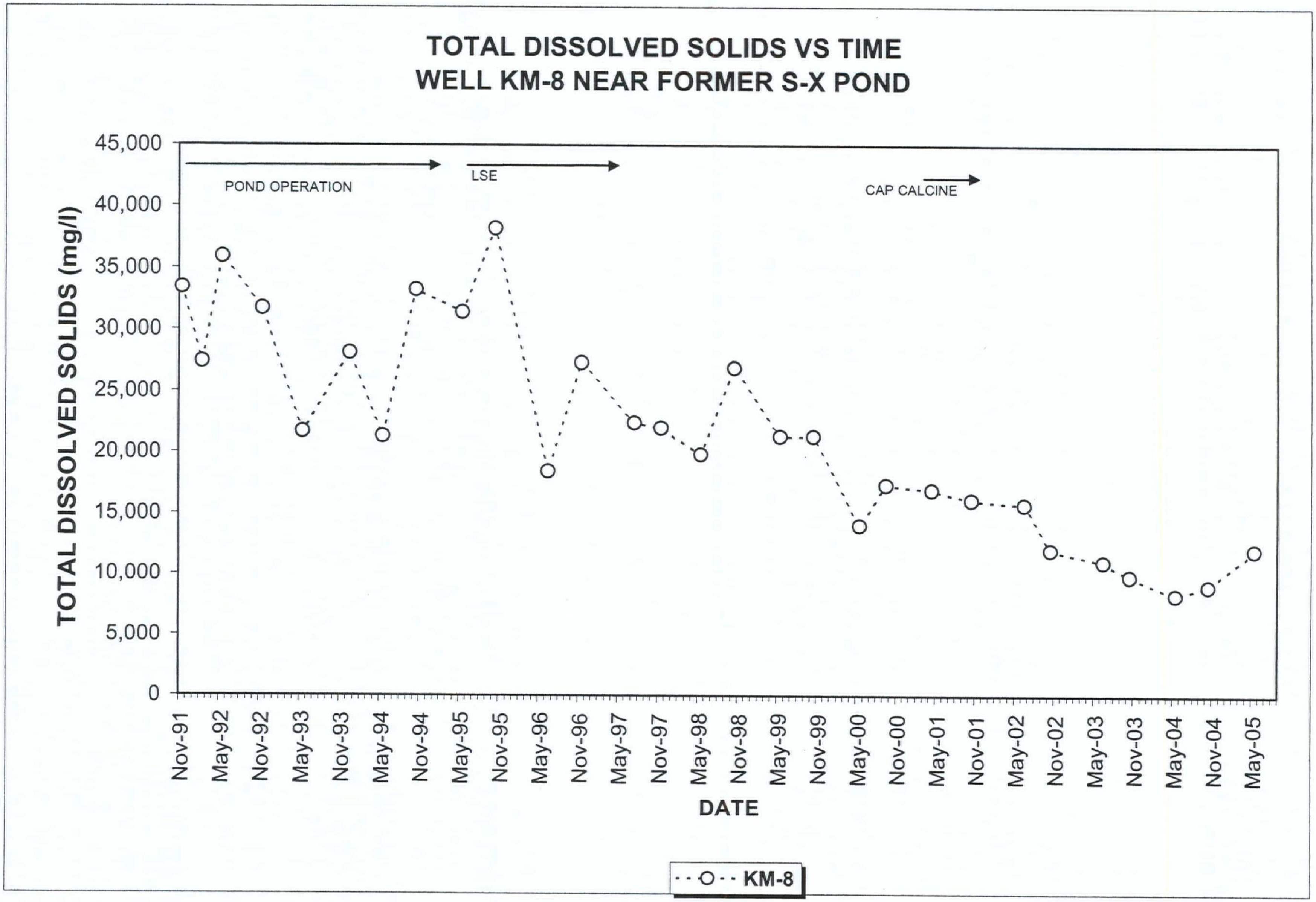
May-04
Nov-04
May-05
DATE
KM-15
KM-16
KM-17
KM-18

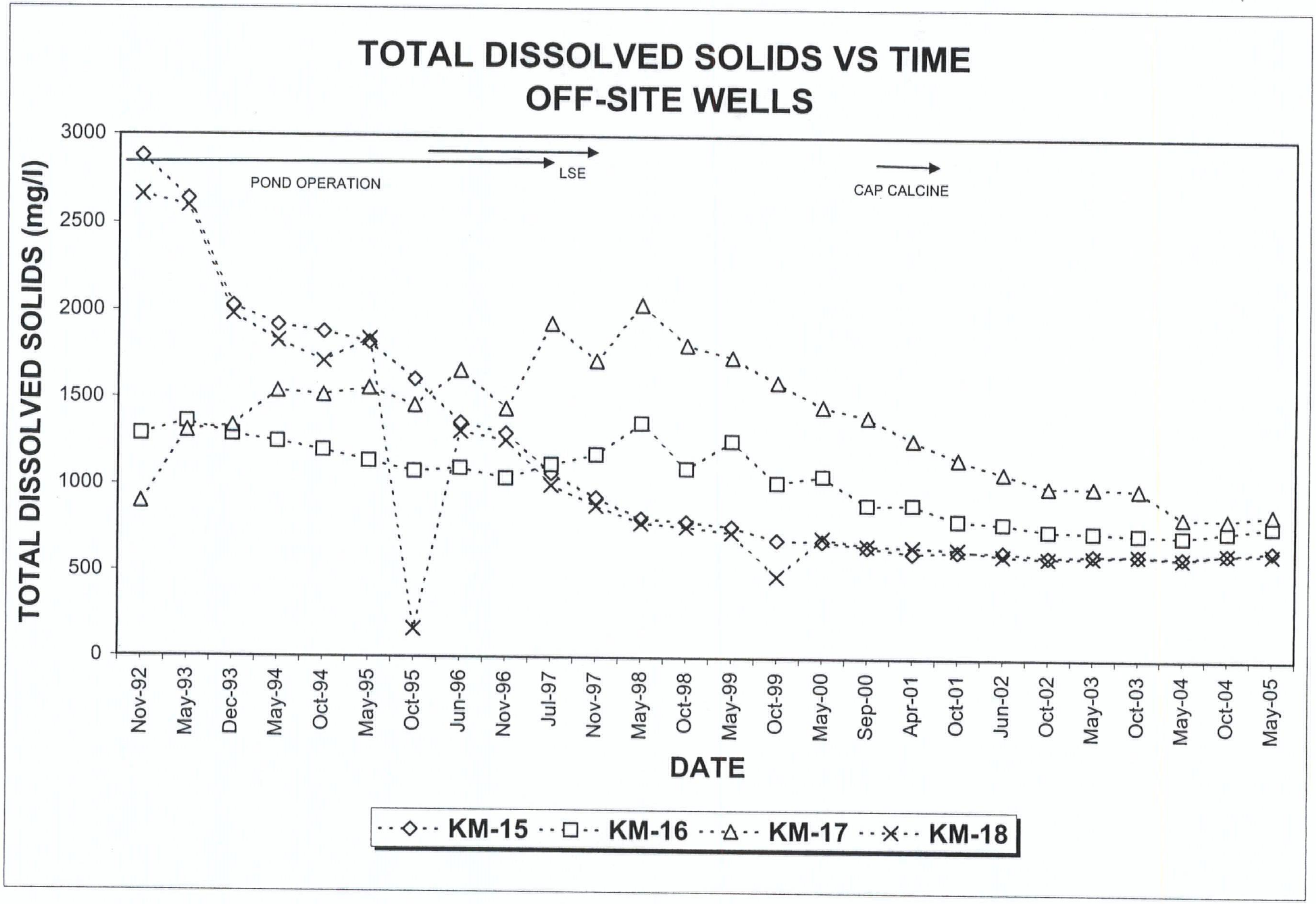

SULFATE VS TIME
FINCH SPRING
POND OPERATION
LSE
CAP CALCINE
SULFATE (mg/l)
350
300
250
200
150
100
50
0
Oct-91
May-92
Nov-92
May-93
Dec-93
May-94
Oct-94
May-95
Oct-95
Jun-96
Nov-96
Jul-97
Nov-97
May-98
Oct-98
May-99
Oct-99
May-00
Sep-00
Apr-01
Oct-01
May-02
Oct-02
Jun-03
Oct-03
May-04
Oct-04
May-05
DATE
FINCH SPRING


SULFATE VS TIME
BIG SPRING
SULFATE (mg/l)
250
200
150
100
50
0
Dec-93
May-94
Oct-94
May-95
Oct-95
Jun-96
Nov-96
Jul-97
Nov-97
May-98
Oct-98
May-99
Oct-99
May-00
Sep-00
Apr-01
Oct-01
May-02
Oct-02
May-03
Oct-03
May-04
Oct-04
May-05
DATE
BIG SPRING


TOTAL DISSOLVED SOLIDS VS TIME
WELLS NEAR FORMER SCRUBBER POND
TOTAL DISSOLVED SOLIDS (mg/l)
16,000
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
POND OPERATION
LSE
CAP CALCINE
Nov-91
May-92
Nov-92
May-93
Nov-93
May-94
Nov-94
May-95
Nov-95
May-96
Nov-96
May-97
Nov-97
May-98
Nov-98
May-99
Nov-99
May-00
Nov-00
May-01
Nov-01
May-02
Nov-02
May-03
Nov-03
May-04
Nov-04
May-05
DATE
KM-2
KM-3
KM-4
KM-11


TOTAL DISSOLVED SOLIDS VS TIME
WELLS NEAR WEST SIDE OF FACILITY
OR NEAR FORMER S-X POND
TOTAL DISSOLVED SOLIDS (mg/l)
3,000
2,000
1,000
0
POND OPERATION
LSE
CAP CALCINE
Nov-91
May-92
Nov-92
May-93
Nov-93
May-94
Nov-94
May-95
Nov-95
May-96
Nov-96
May-97
Nov-97
May-98
Nov-98
May-99
Nov-99
May-00
Nov-00
May-01
Nov-01
May-02
Nov-02
May-03
Nov-03
May-04
Nov-04
May-05
DATE
KM-5
KM-6
KM-7
KM-9
KM-12
KM-13
KM-19


TOTAL DISSOLVED SOLIDS VS TIME
WELL KM-8 NEAR FORMER S-X POND
TOTAL DISSOLVED SOLIDS (mg/l)
45,000
40,000
35,000
30,000
25,000
20,000
15,000
10,000
5,000
0
POND OPERATION
LSE
CAP CALCINE
Nov-91
May-92
Nov-92
May-93
Nov-93
May-94
Nov-94
May-95
Nov-95
May-96
Nov-96
May-97
Nov-97
May-98
Nov-98
May-99
Nov-99
May-00
Nov-00
May-01
Nov-01
May-02
Nov-02
May-03
Nov-03
May-04
Nov-04
May-05
DATE
KM-8


TOTAL DISSOLVED SOLIDS VS TIME
OFF-SITE WELLS
TOTAL DISSOLVED SOLIDS (mg/l)
3000
2500
2000
1500
1000
500
0
POND OPERATION
LSE
CAP CALCINE
Nov-92
May-93
Dec-93
May-94
Oct-94
May-95
Oct-95
Jun-96
Nov-96
Jul-97
Nov-97
May-98
Oct-98
May-99
Oct-99
May-00
Sep-00
Apr-01
Oct-01
Jun-02
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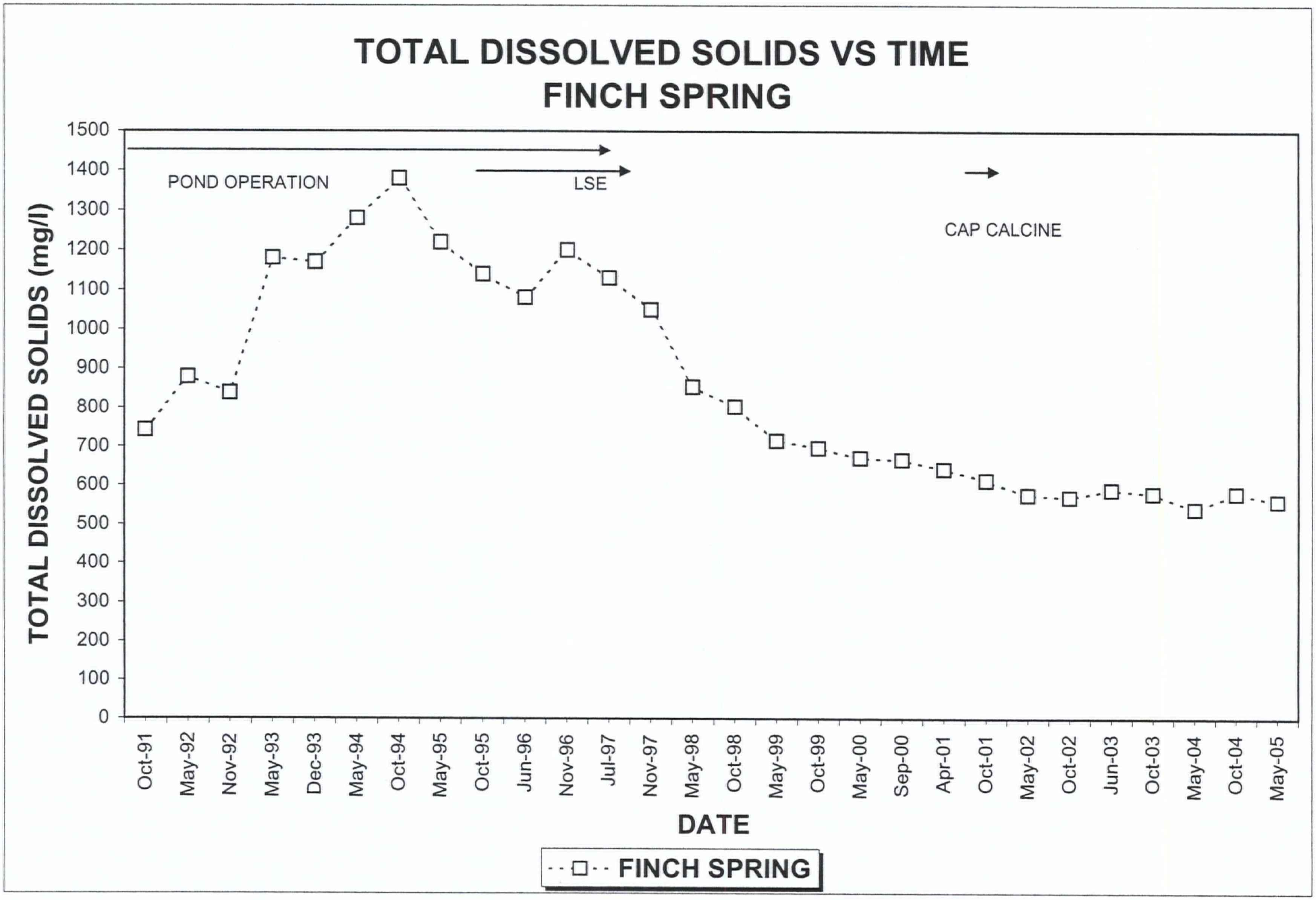
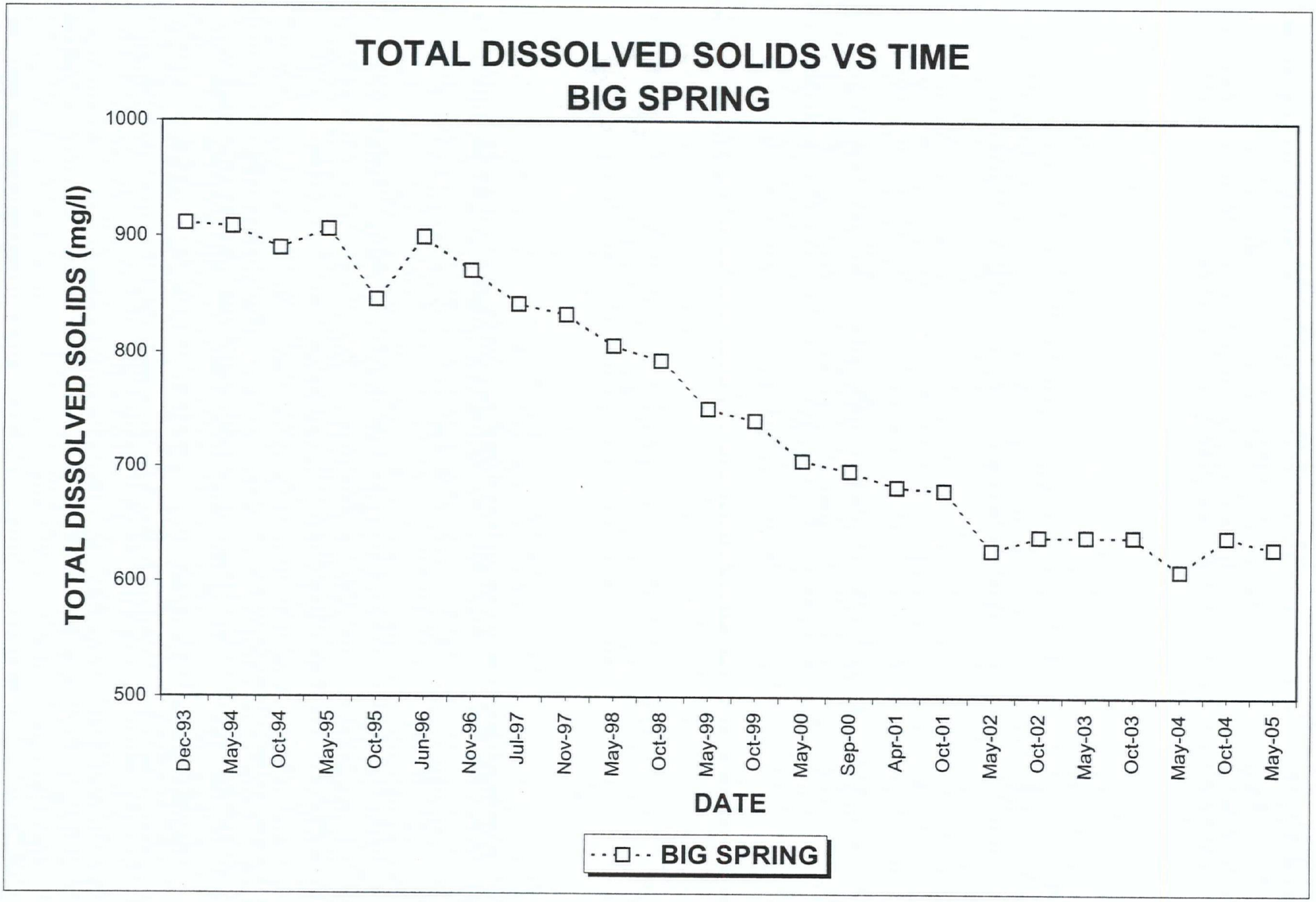
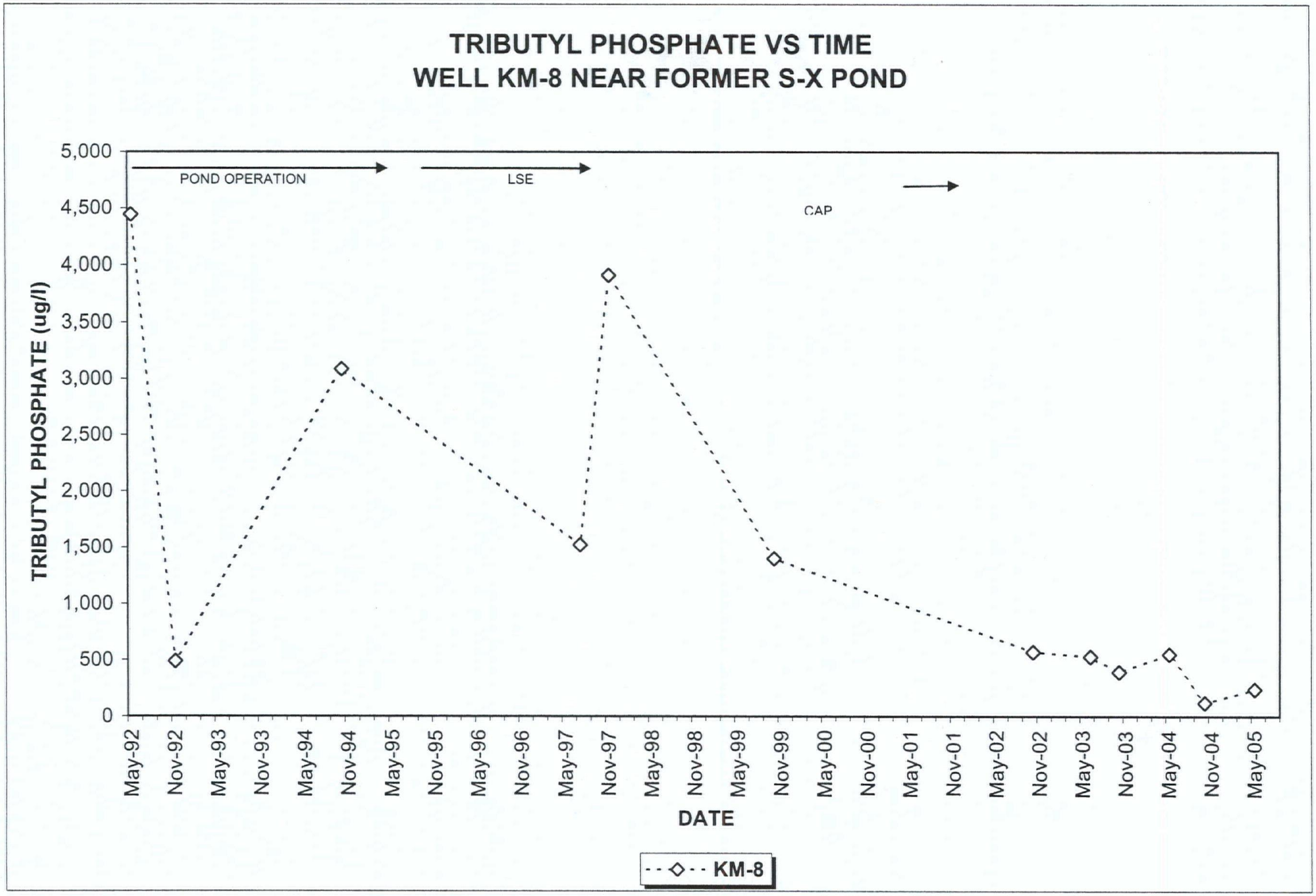
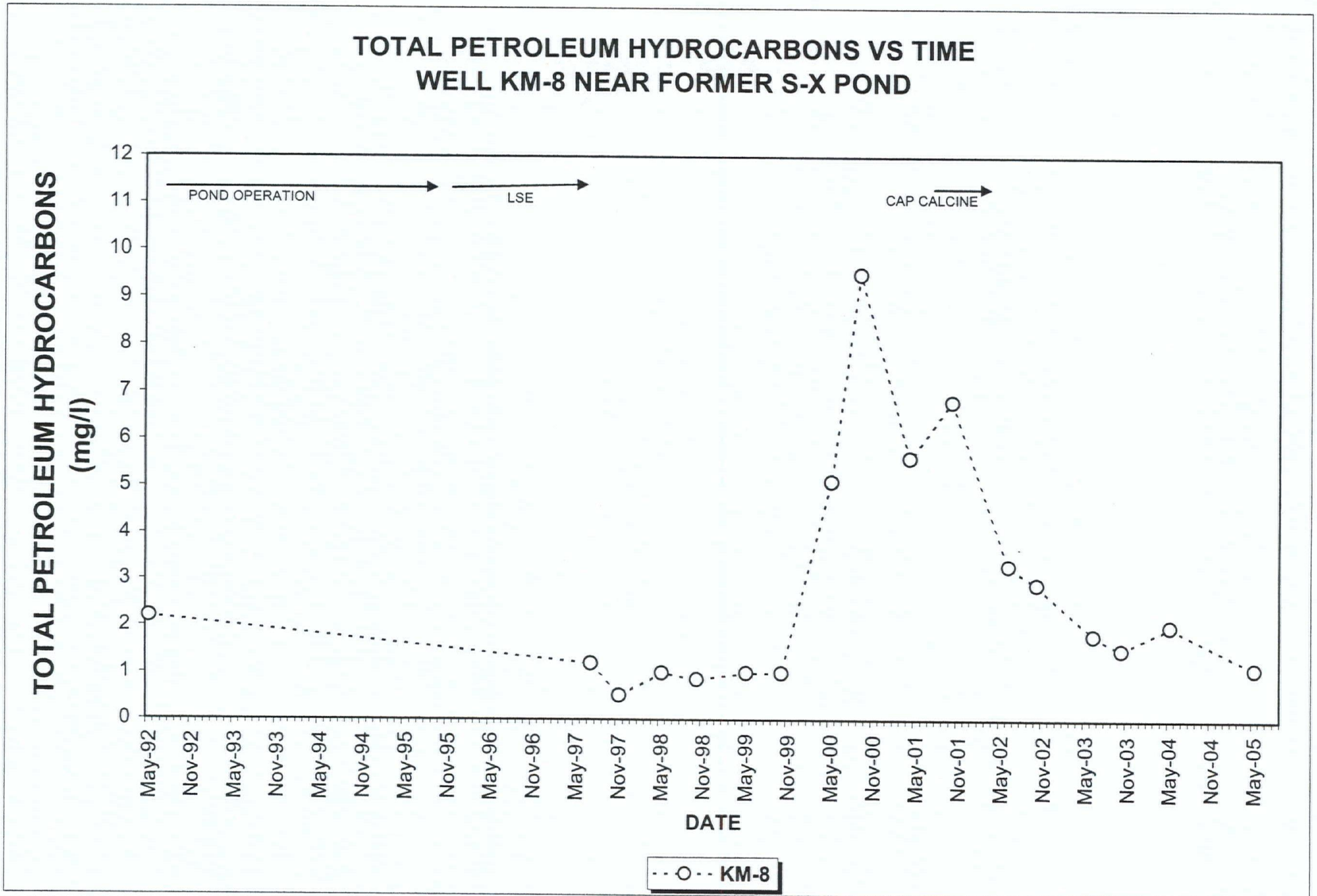
May-03
Oct-03
May-04
Oct-04
May-05
DATE
KM-15
KM-16
KM-17
KM-18


TOTAL DISSOLVED SOLIDS VS TIME
FINCH SPRING
TOTAL DISSOLVED SOLIDS (mg/l)
1500
1400
1300
1200
1100
1000
900
800
700
600
500
400
300
200
100
0
POND OPERATION
LSE
CAP CALCINE
Oct-91
May-92
Nov-92
May-93
Dec-93
May-94
Oct-94
May-95
Oct-95
Jun-96
Nov-96
Jul-97
Nov-97
May-98
Oct-98
May-99
Oct-99
May-00
Sep-00
Apr-01
Oct-01
May-02
Oct-02
Jun-03
Oct-03
May-04
Oct-04
May-05
DATE
FINCH SPRING

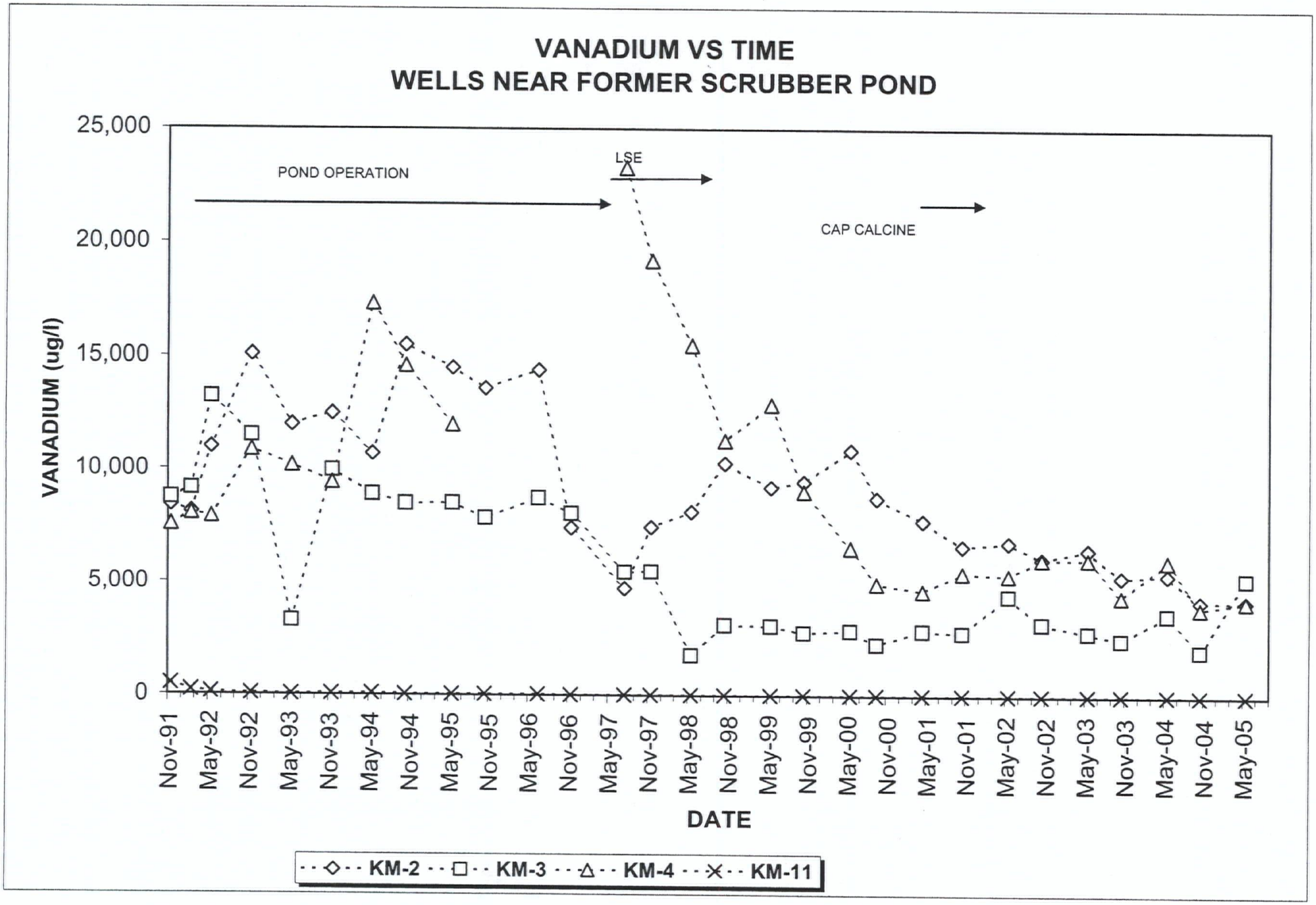

TOTAL DISSOLVED SOLIDS VS TIME
BIG SPRING
TOTAL DISSOLVED SOLIDS (mg/l)
1000
900
800
700
600
500
Dec-93
May-94
Oct-94
May-95
Oct-95
Jun-96
Nov-96
Jul-97
Nov-97
May-98
Oct-98
May-99
Oct-99
May-00
Sep-00
Apr-01
Oct-01
May-02
Oct-02
May-03
Oct-03
May-04
Oct-04
May-05
DATE
BIG SPRING



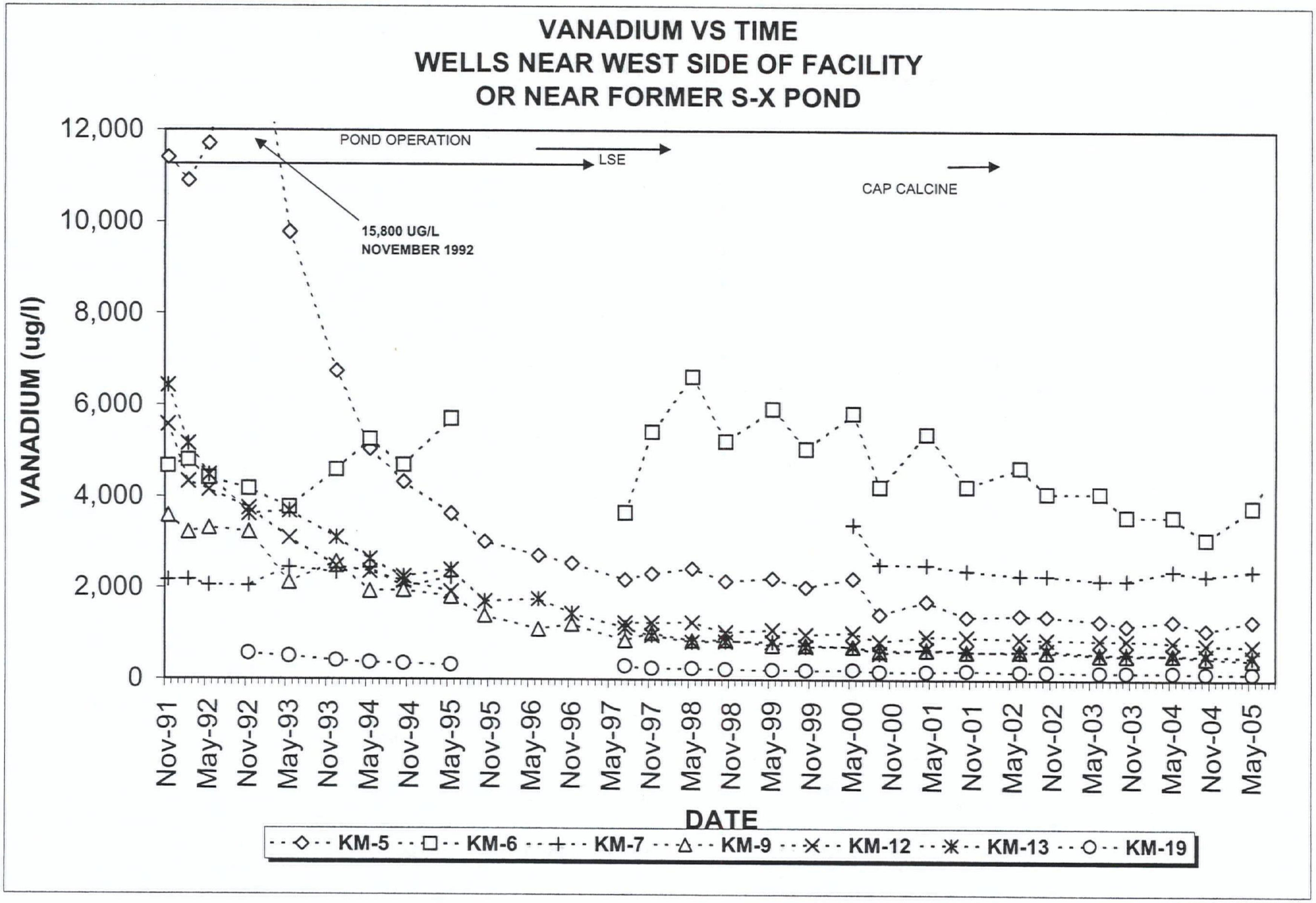
RBC FOR TRIBUTYL PHOSPHATE IS 180 ug/l
KM-8 IS A POC WELL
VALUES ESTIMATED AS DETECTED



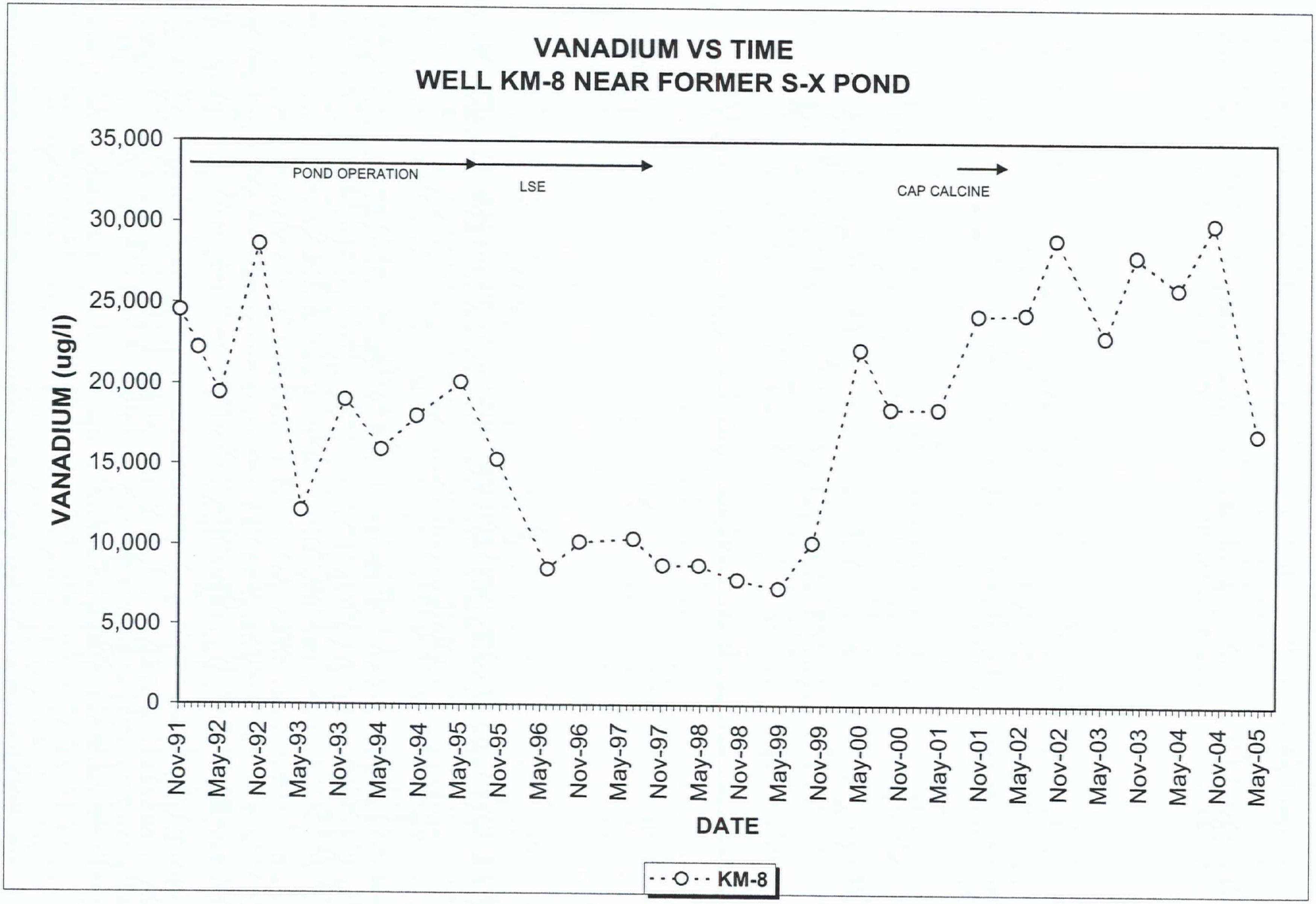
RBC FOR TPH IS 0.73 mg/l
KM-8 IS A POC WELL
1999 VALUES LESS THAN DETECTION



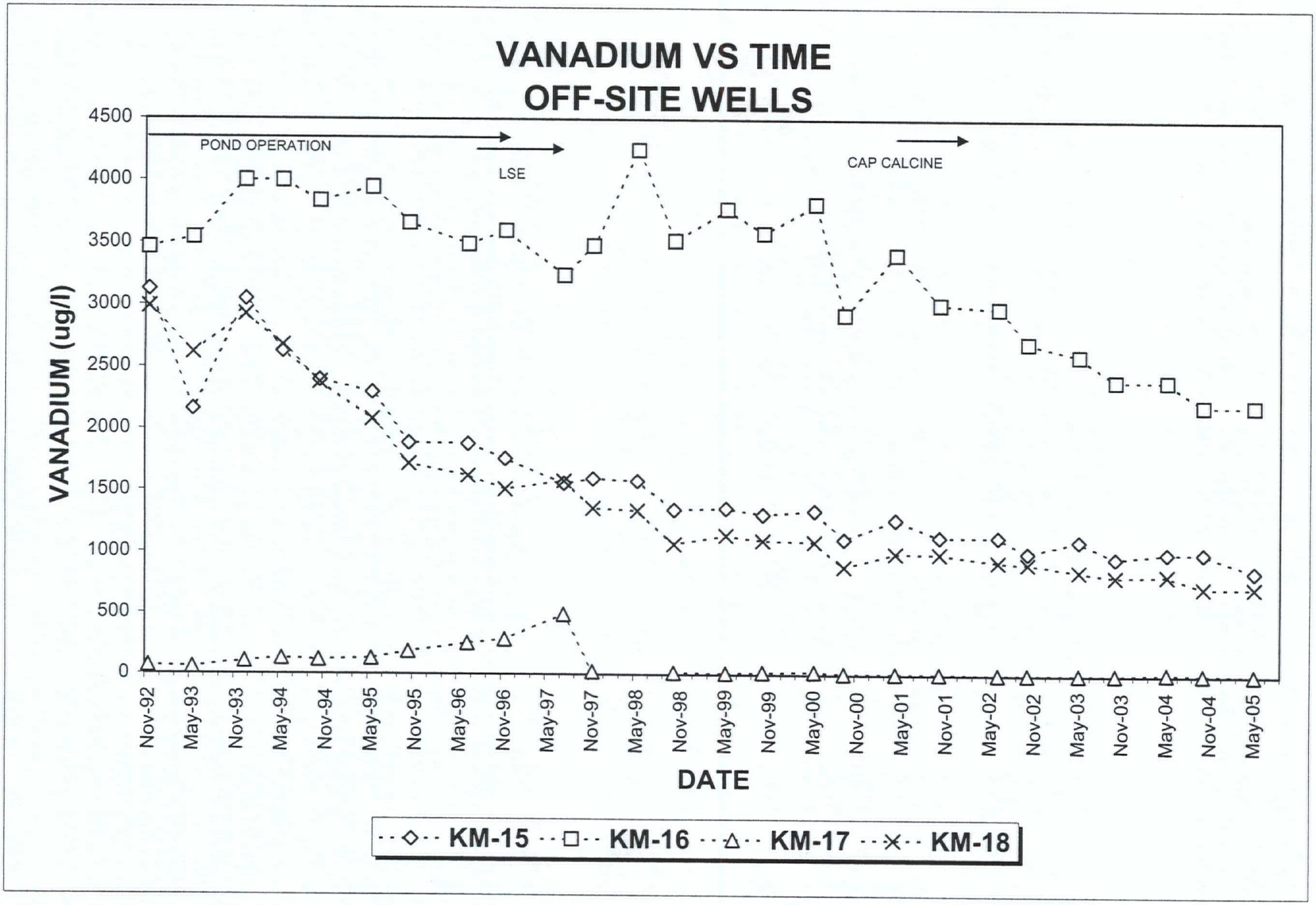
RBC FOR VANADIUM IS 260 ug/l
KM-2, KM-3, KM-11 ARE POC WELLS

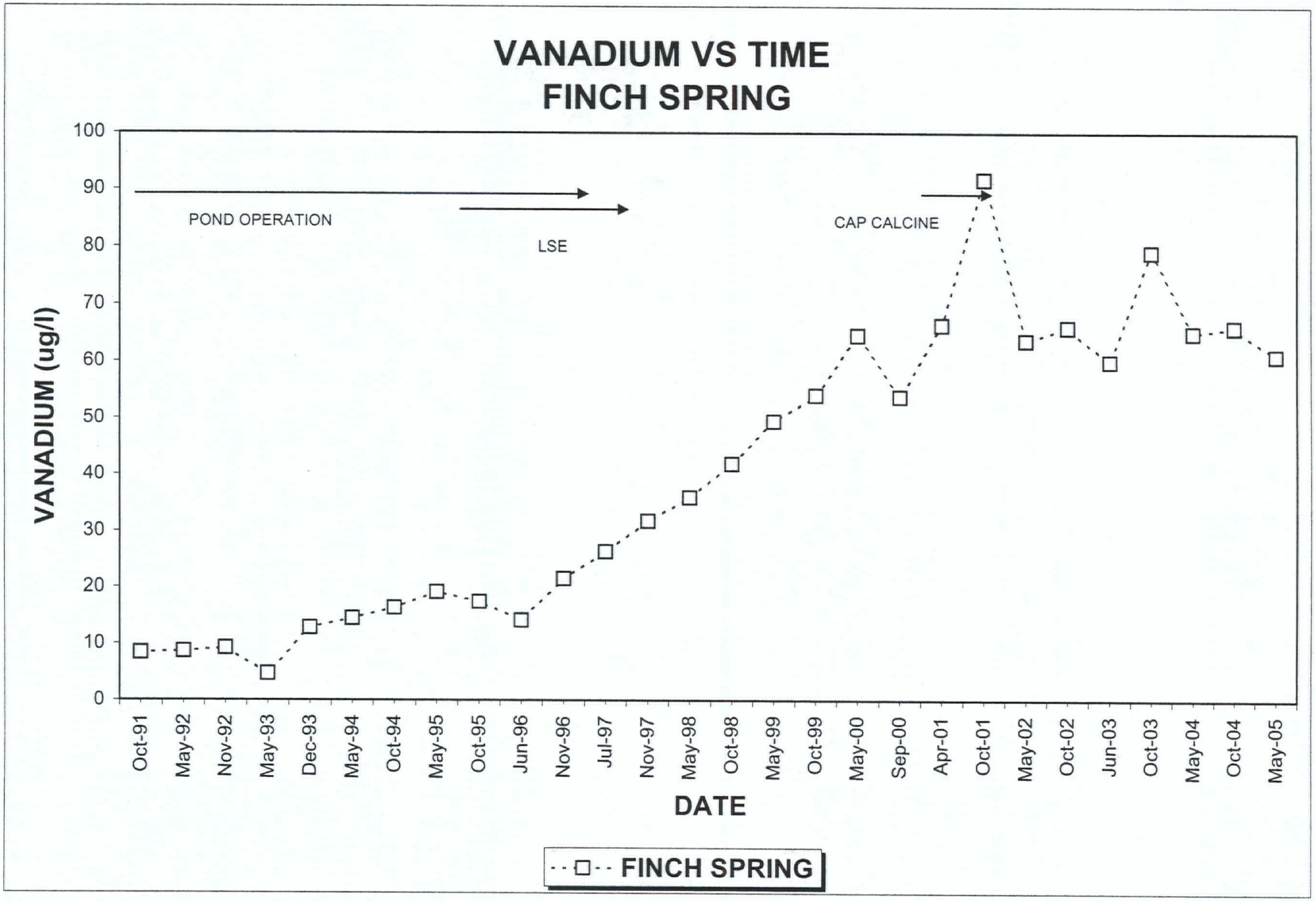


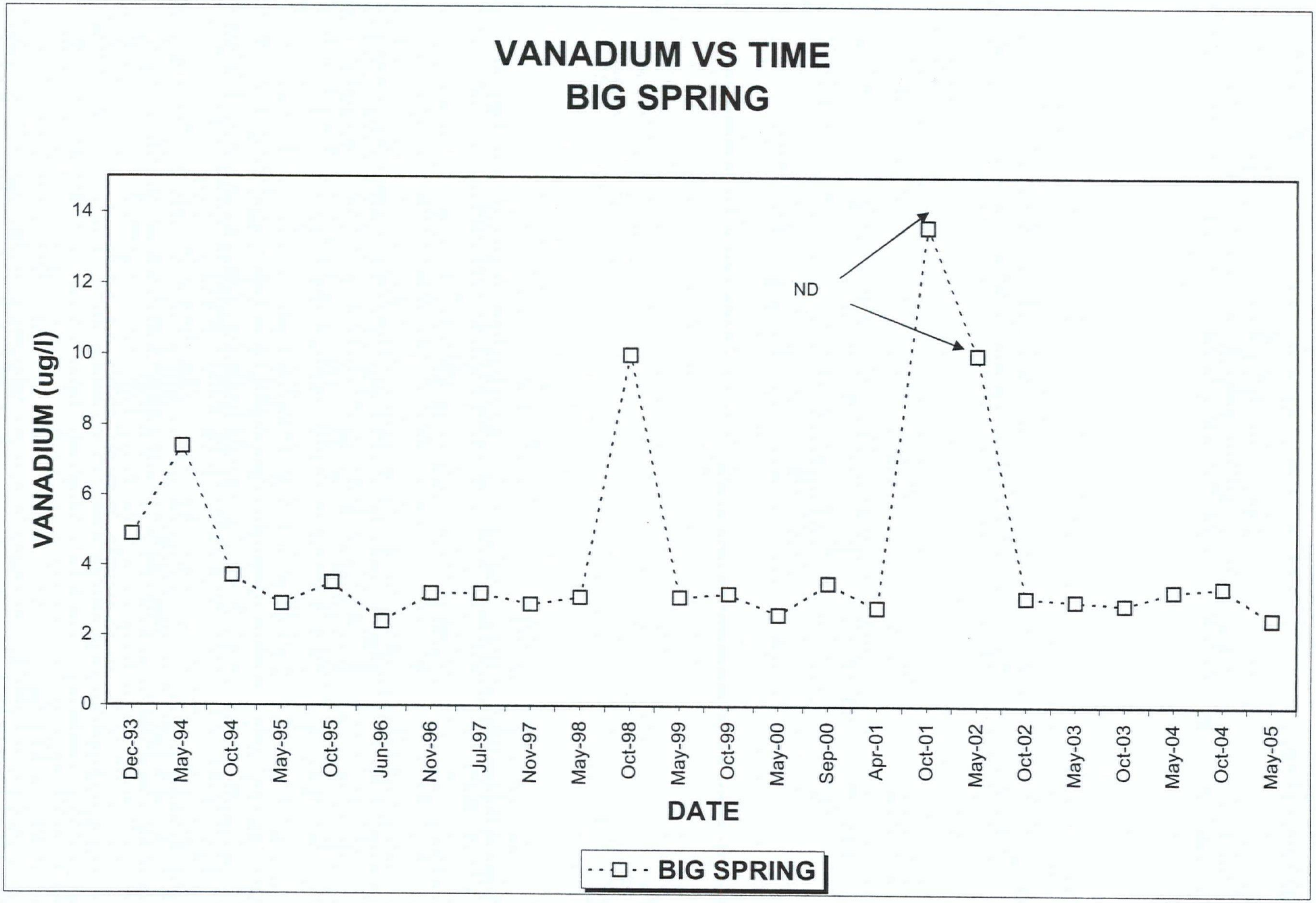
RBC FOR VANADIUM IS 260 ug/l
KM-5, KM-9, KM-12, KM-13, KM-19 ARE POC WELLS



RBC FOR VANADIUM IS 260 ug/l
KM-8 IS A POC WELLS


VANADIUM VS TIME
OFF-SITE WELLS
POND OPERATION
LSE
CAP CALCINE
VANADIUM (ug/l)
4500
4000
3500
3000
2500
2000
1500
1000
500
0
Nov-92
May-93
Nov-93
May-94
Nov-94
May-95
Nov-95
May-96
Nov-96
May-97
Nov-97
May-98
Nov-98
May-99
Nov-99
May-00
Nov-00
May-01
Nov-01
May-02
Nov-02
May-03
Nov-03
May-04
Nov-04
May-05
DATE
KM-15
KM-16
KM-17
KM-18


VANADIUM VS TIME
FINCH SPRING
VANADIUM (ug/l)
0
10
20
30
40
50
60
70
80
90
100
POND OPERATION
LSE
CAP CALCINE
Oct-91
May-92
Nov-92
May-93
Dec-93
May-94
Oct-94
May-95
Oct-95
Jun-96
Nov-96
Jul-97
Nov-97
May-98
Oct-98
May-99
Oct-99
May-00
Sep-00
Apr-01
Oct-01
May-02
Oct-02
Jun-03
Oct-03
May-04
Oct-04
May-05
DATE
FINCH SPRING



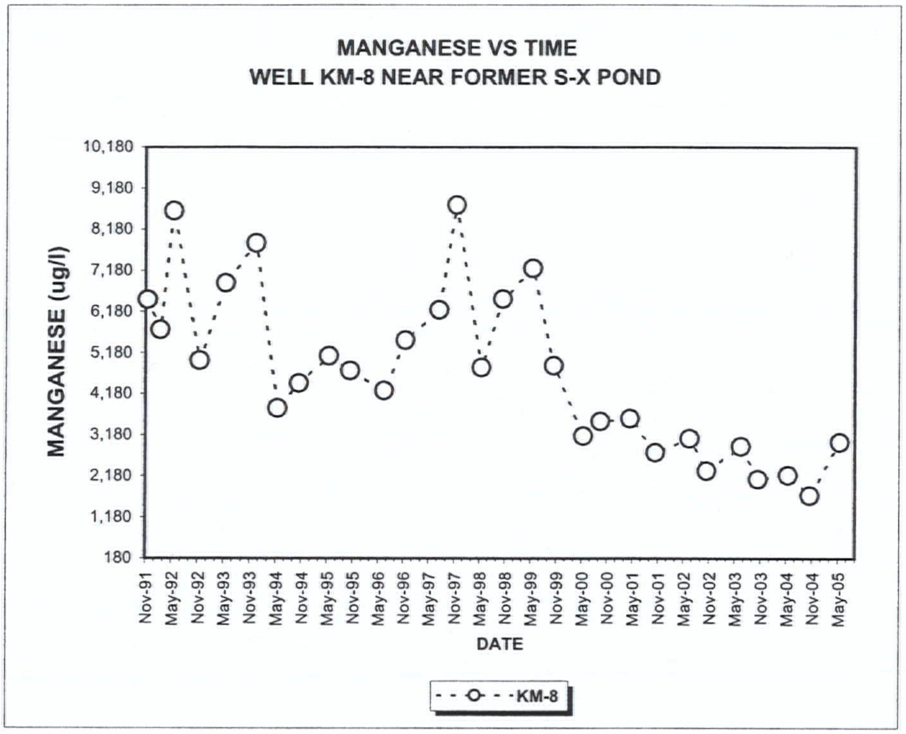
October 1998 value less than detection

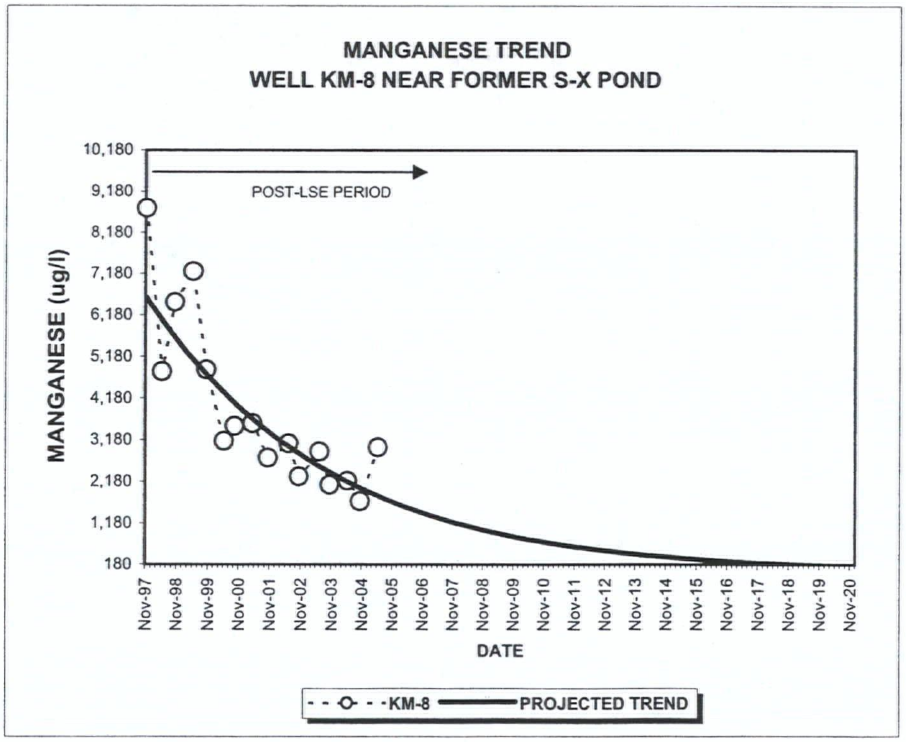
Appendix B

APPENDIX B

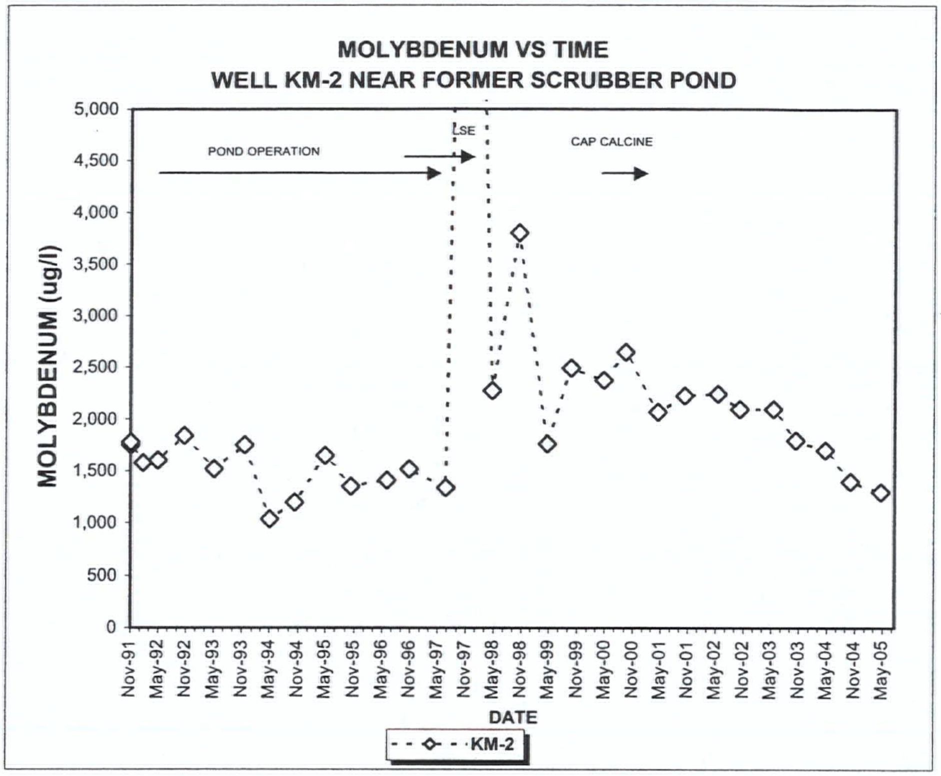
COC CONCENTRATION TRENDS WITH TIME APPENDIX AND PROJECTED TRENDS

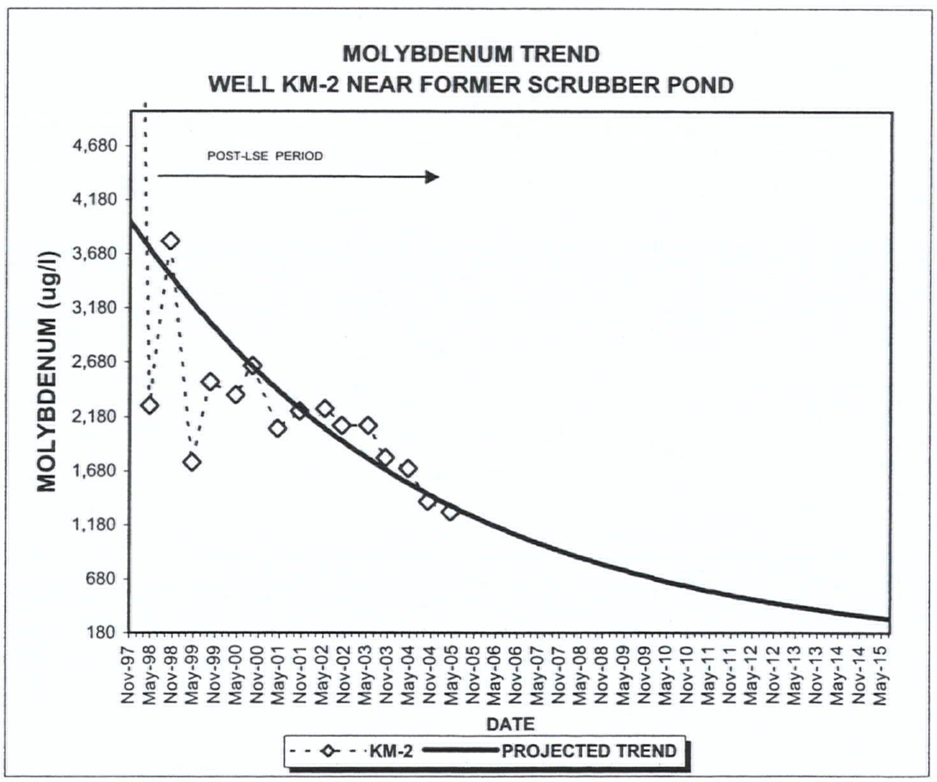
COC CONCENTRATION TRENDS WITH TIME AND PROJECTED TRENDS



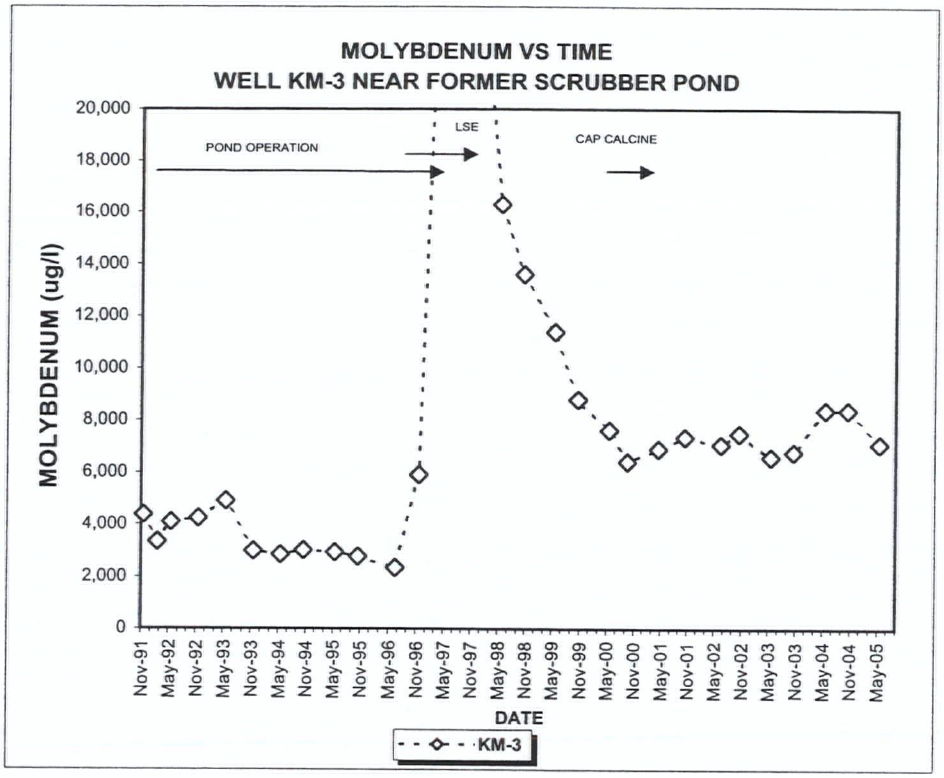


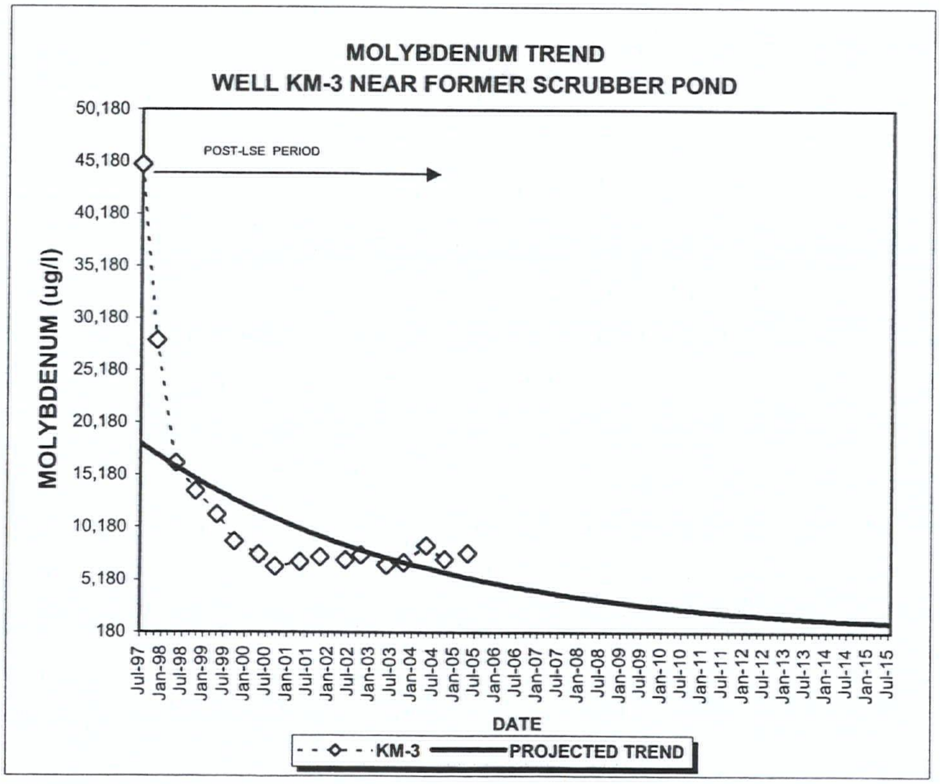
RBC FOR MOLYBDENUM IS 180 UG/L
KM-8 IS A POC WELL
PROJECTED TRENDS BASED ON OBSERVATIONS FOLLOWING LSE AND RECLAMATION


MOLYBDENUM VS TIME
WELL KM-2 NEAR FORMER SCRUBBER POND
MOLYBDENUM (ug/l)
5,000
4,500
4,000
3,500
3,000
2,500
2,000
1,500
1,000
500
0
POND OPERATION
LSE
CAP CALCINE
Nov-91
May-92
Nov-92
May-93
Nov-93
May-94
Nov-94
May-95
Nov-95
May-96
Nov-96
May-97
Nov-97
May-98
Nov-98
May-99
Nov-99
May-00
Nov-00
May-01
Nov-01
May-02
Nov-02
May-03
Nov-03
May-04
Nov-04
May-05
DATE
KM-2


MOLYBDENUM TREND
WELL KM-2 NEAR FORMER SCRUBBER POND
MOLYBDENUM (ug/l)
4,680
4,180
3,680
3,180
2,680
2,180
1,680
1,180
680
180
POST-LSE PERIOD
Nov-97
May-98
Nov-98
May-99
Nov-99
May-00
Nov-00
May-01
Nov-01
May-02
Nov-02
May-03
Nov-03
May-04
Nov-04
May-05
Nov-05
May-06
Nov-06
May-07
Nov-07
May-08
Nov-08
May-09
Nov-09
May-10
Nov-10
May-11
Nov-11
May-12
Nov-12
May-13
Nov-13
May-14
Nov-14
May-15
DATE
KM-2
PROJECTED TREND

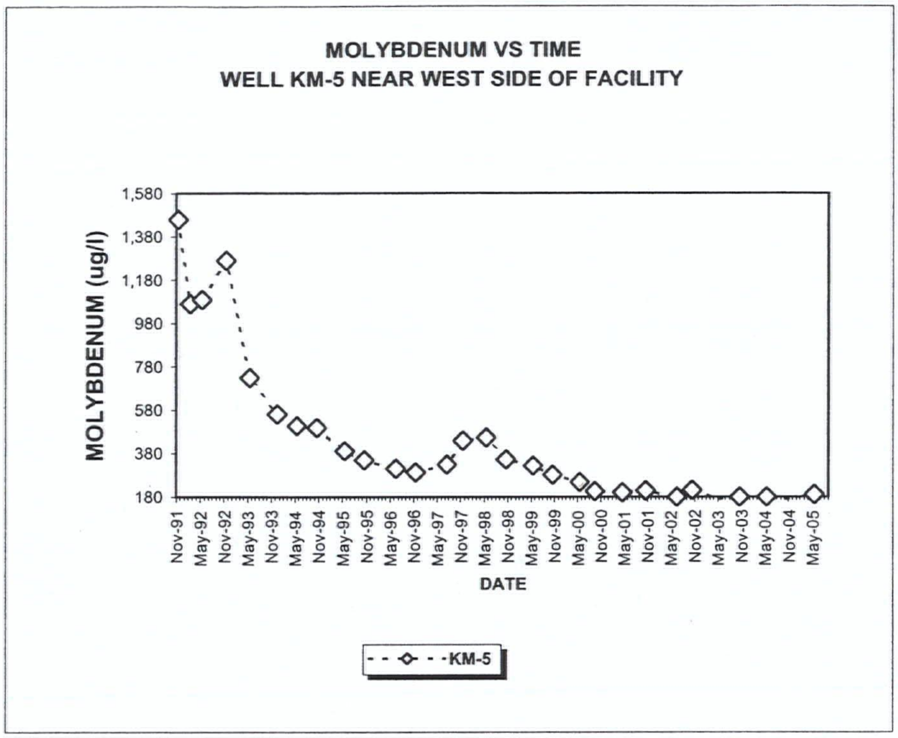
FIGURE

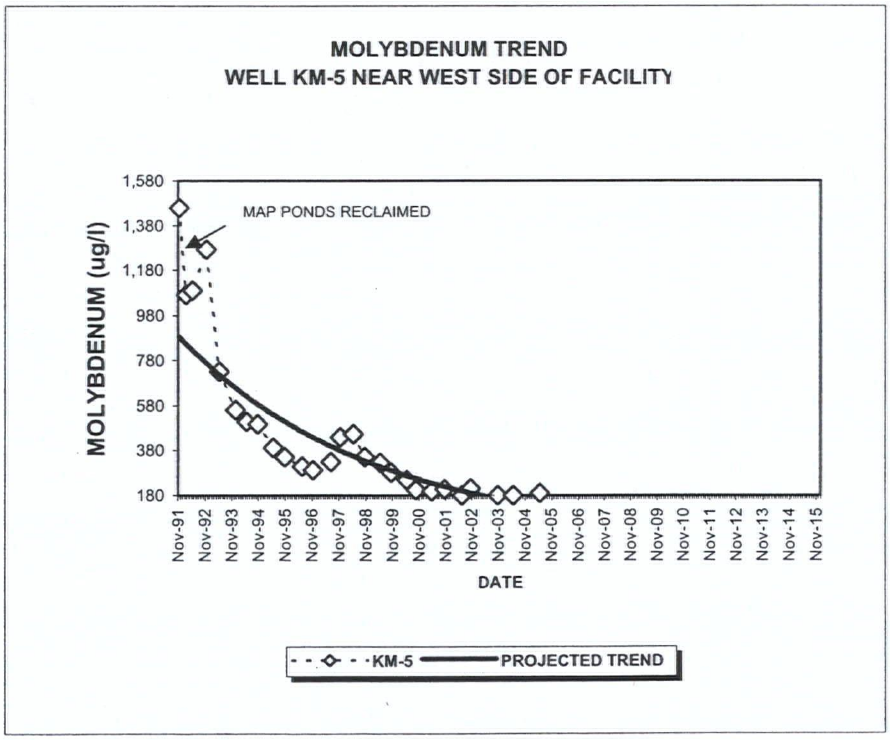

MOLYBDENUM VS TIME
WELL KM-3 NEAR FORMER SCRUBBER POND
MOLYBDENUM (ug/l)
DATE
POND OPERATION
LSE
CAP CALCINE
KM-3


MOLYBDENUM TREND
WELL KM-3 NEAR FORMER SCRUBBER POND
MOLYBDENUM (ug/l)
DATE
POST-LSE PERIOD
KM-3
PROJECTED TREND

FIGURE

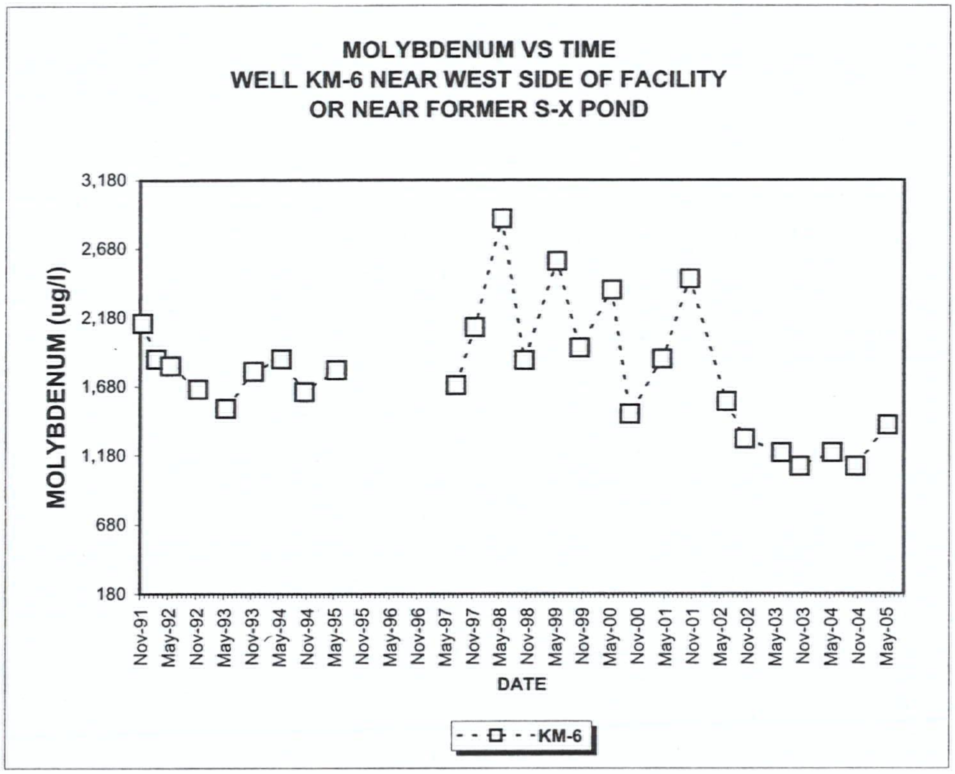
COC CONCENTRATION TRENDS WITH TIME AND PROJECTED TRENDS

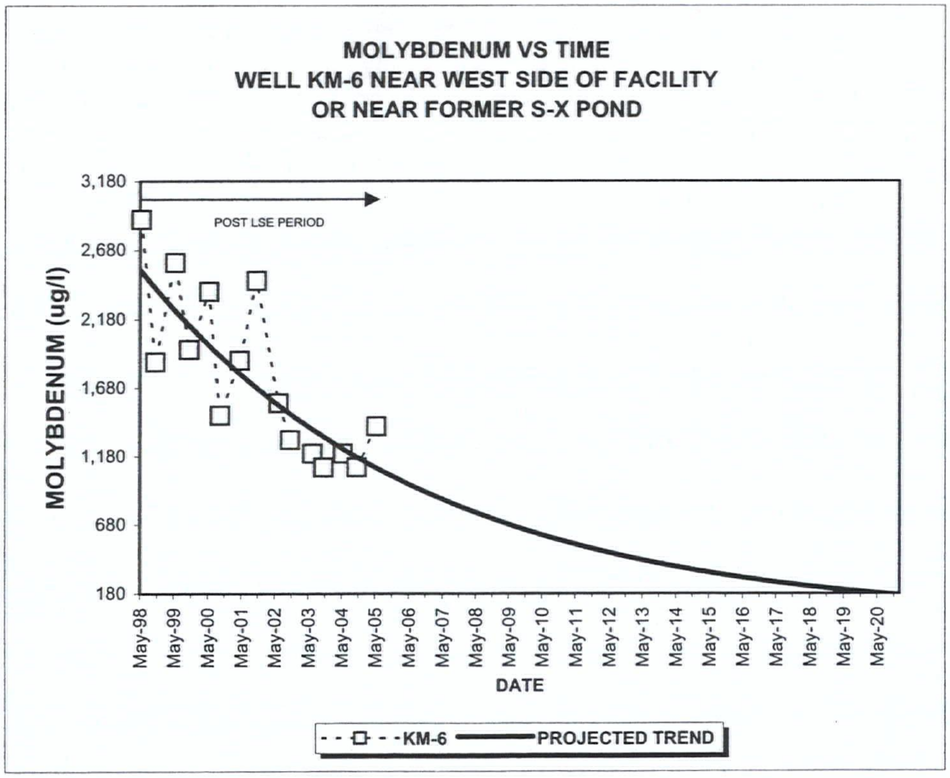




RBC FORMOLYBDENUM IS 180 UG/L
KM-5 IS A POC WELL
PROJECTED TRENDS BASED ON OBSERVATIONS FOLLOWING LSE

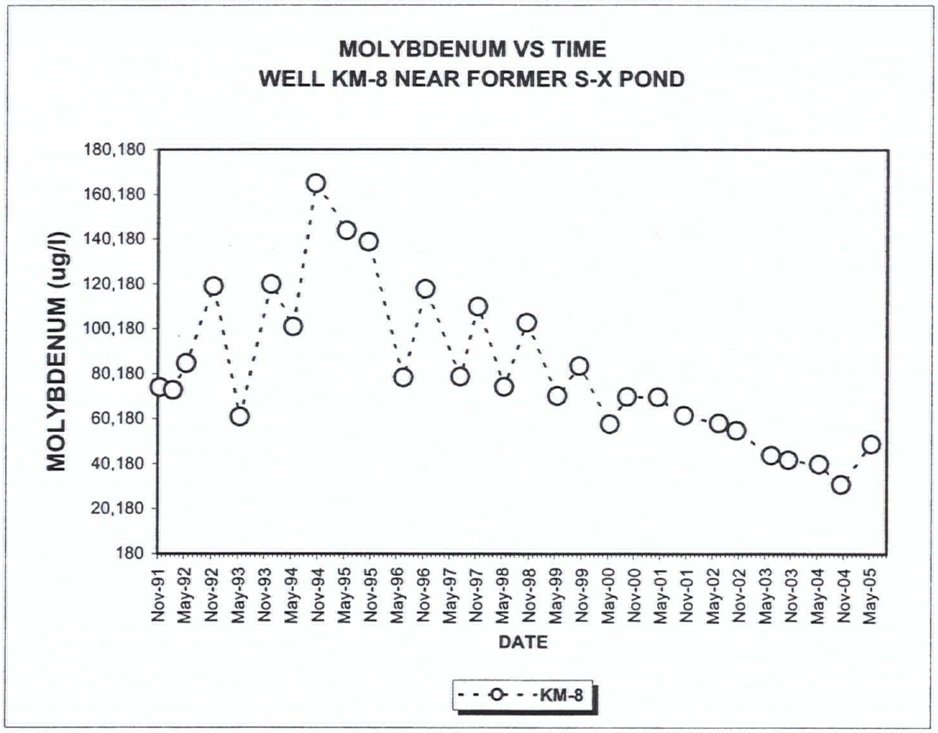
COC CONCENTRATIONS AND PROJECTED TRENDS VERSUS TIME

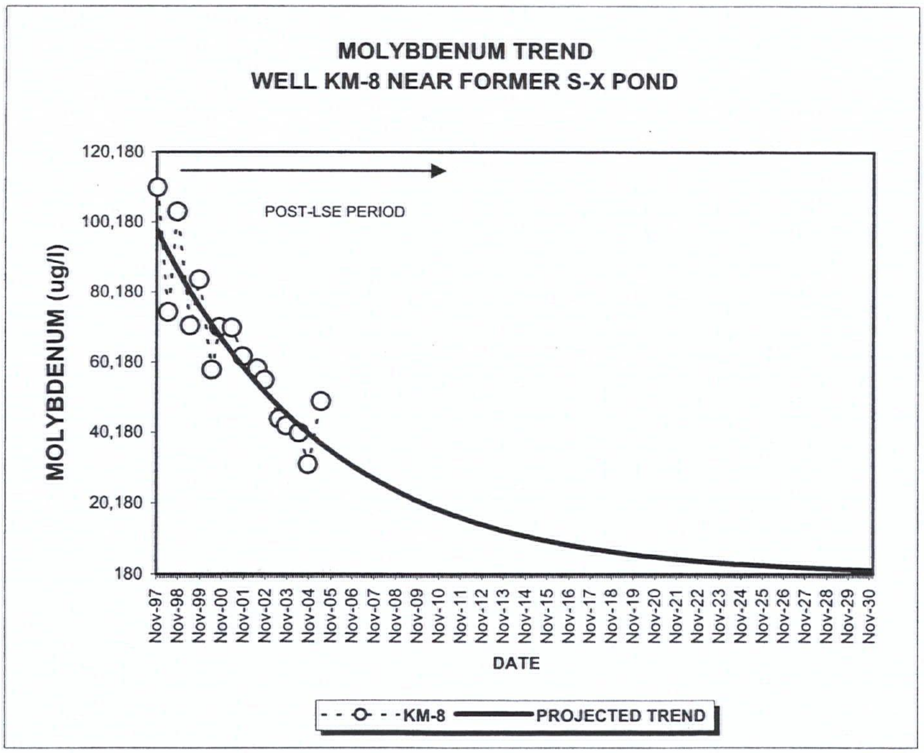




RBC FOR VANADIUM IS 260 UG/L

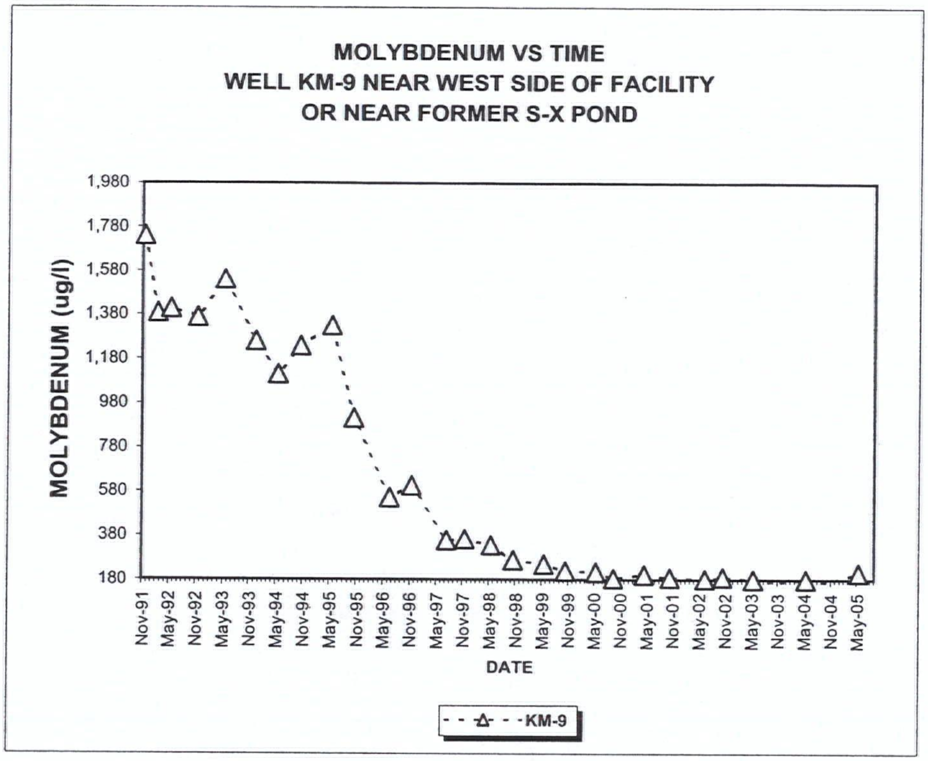
COC CONCENTRATION TRENDS WITH TIME AND PROJECTED TRENDS

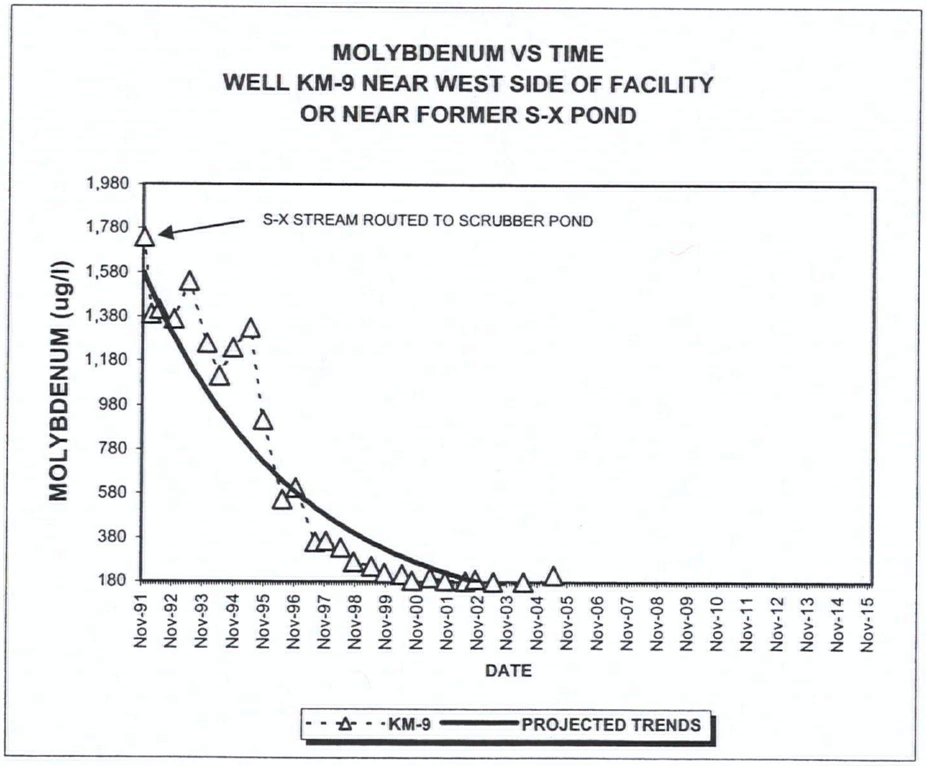




RBC FOR MOLYBDENUM IS 180 UG/L
KM-8 IS A POC WELL
PROJECTED TRENDS BASED ON OBSERVATIONS FOLLOWING LSE AND RECLAMATION

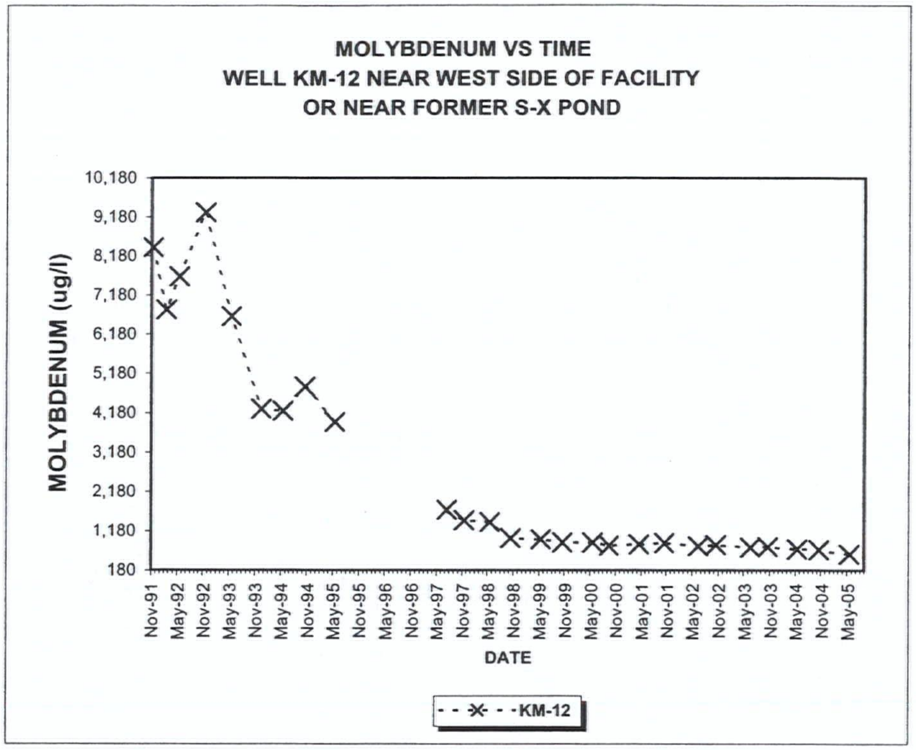
COC CONCENTRATION TRENDS WITH TIME AND PROJECTED TRENDS

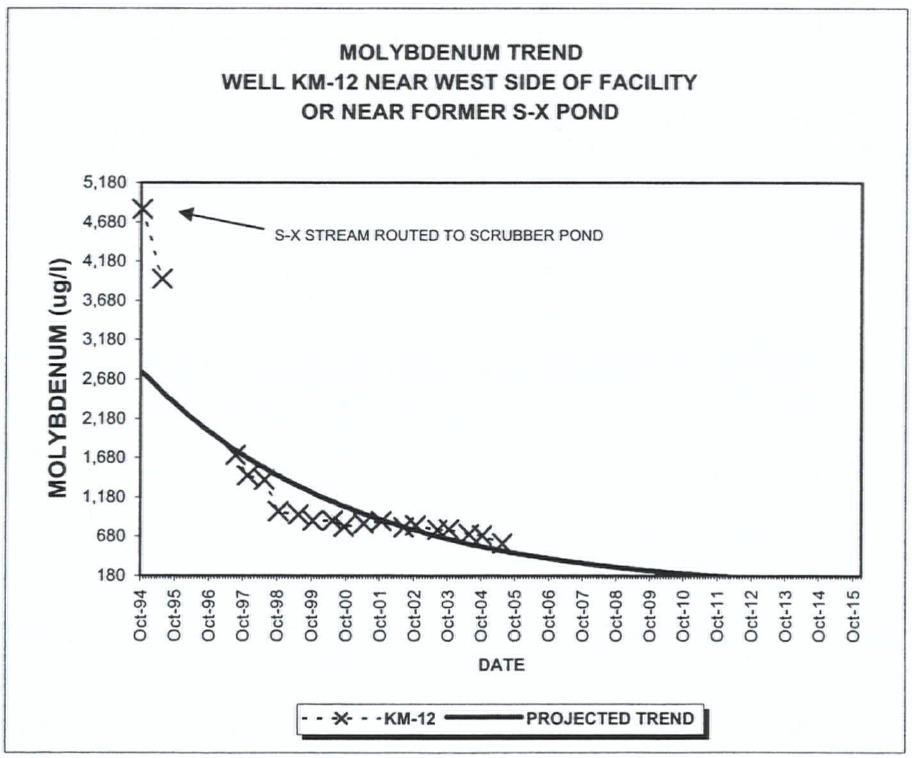




RBC FOR MOLYBDENUM IS 180 UG/L
KM-9 IS A POC WELL
PROJECTED TRENDS BASED ON OBSERVATIONS FOLLOWING REROUTING OF S-X STREAM

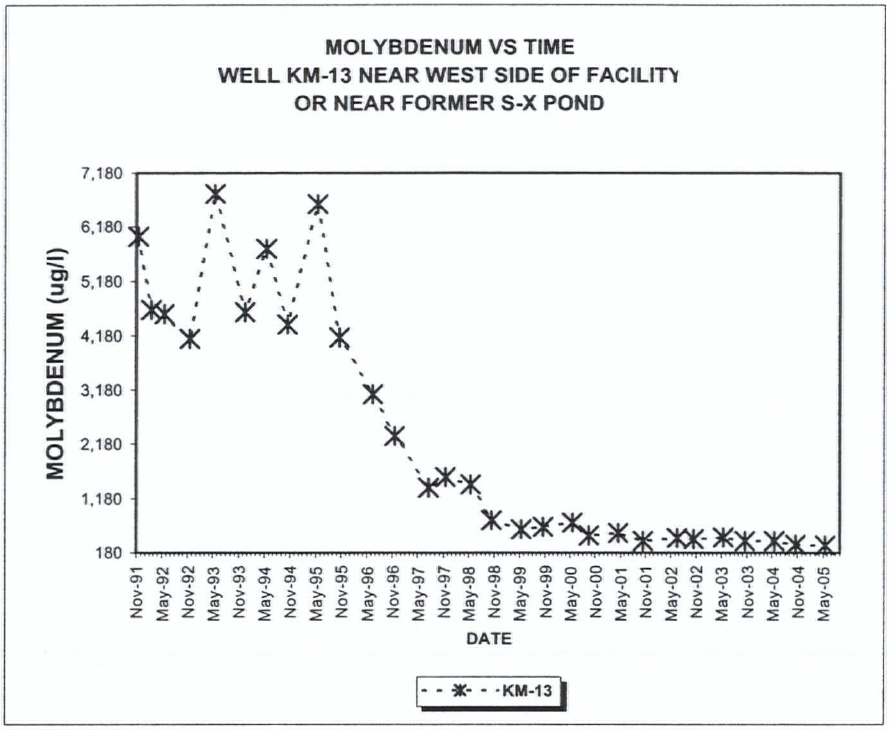
COC CONCENTRATION TRENDS WITH TIME AND PROJECTED TRENDS

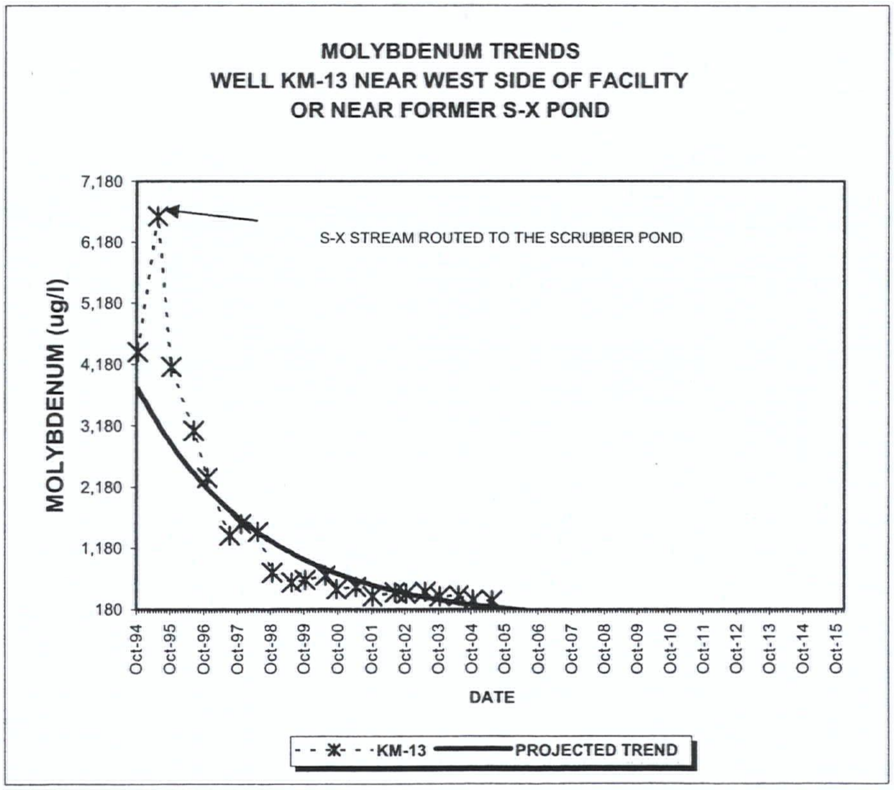




RBC FOR VANADIUM IS 260 UG/L
KM-12 IS A POC WELL
PROJECTED TRENDS BASED ON OBSERVATIONS FOLLOWING REROUTING OF THE S-X STREAM

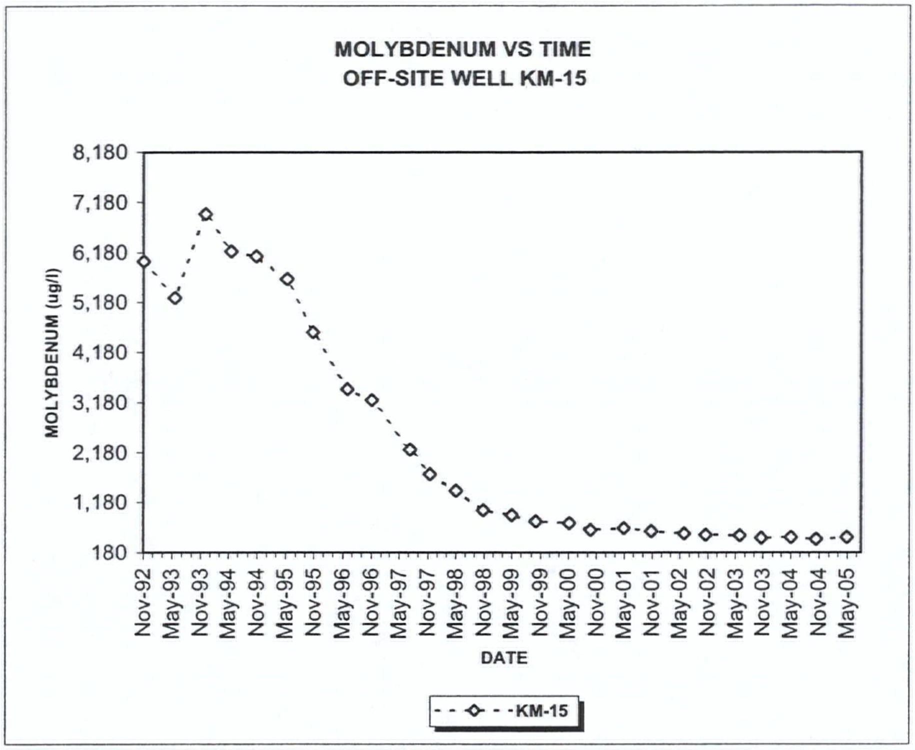
COC CONCENTRATION TRENDS WITH TIME AND PROJECTED TRENDS

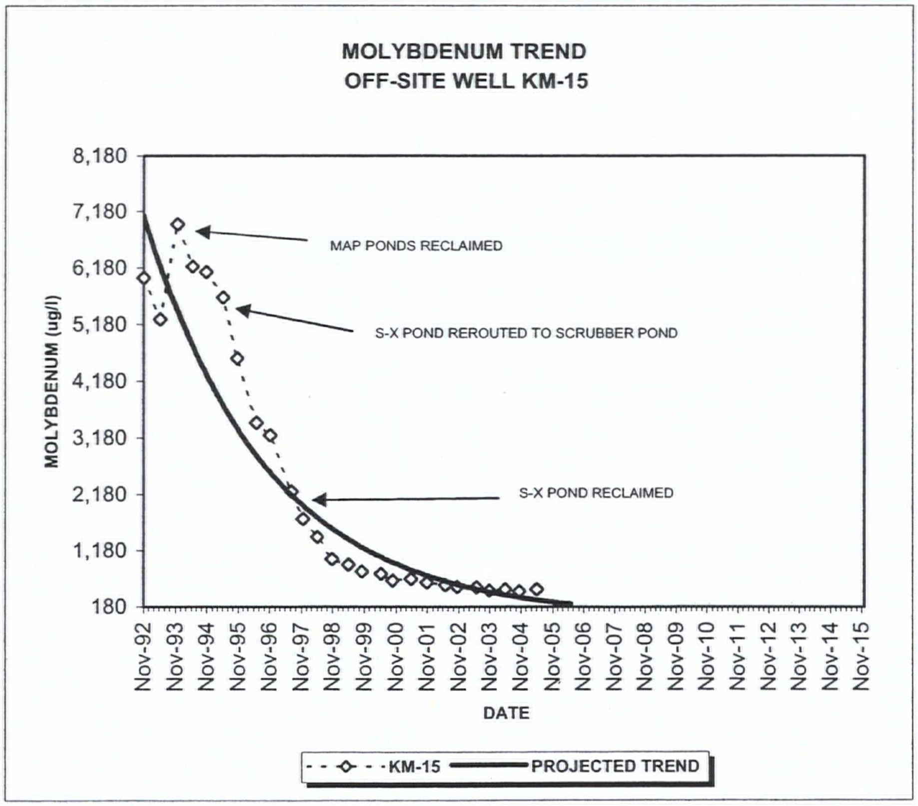




RBC FOR VANADIUM IS 260 UG/L
KM-13 IS A POC WELL
PROJECTED TRENDS BASED ON OBSERVATIONS FOLLOWING REROUTING OF THE S-X STREAM

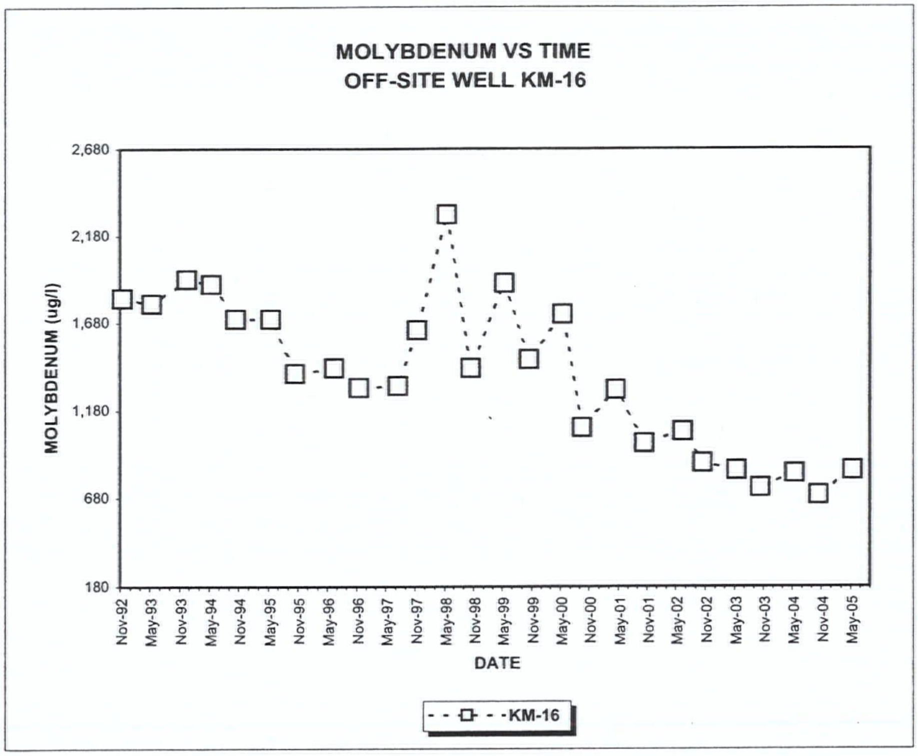
COC CONCENTRATIONS WITH TIME AND PROJECTED TRENDS

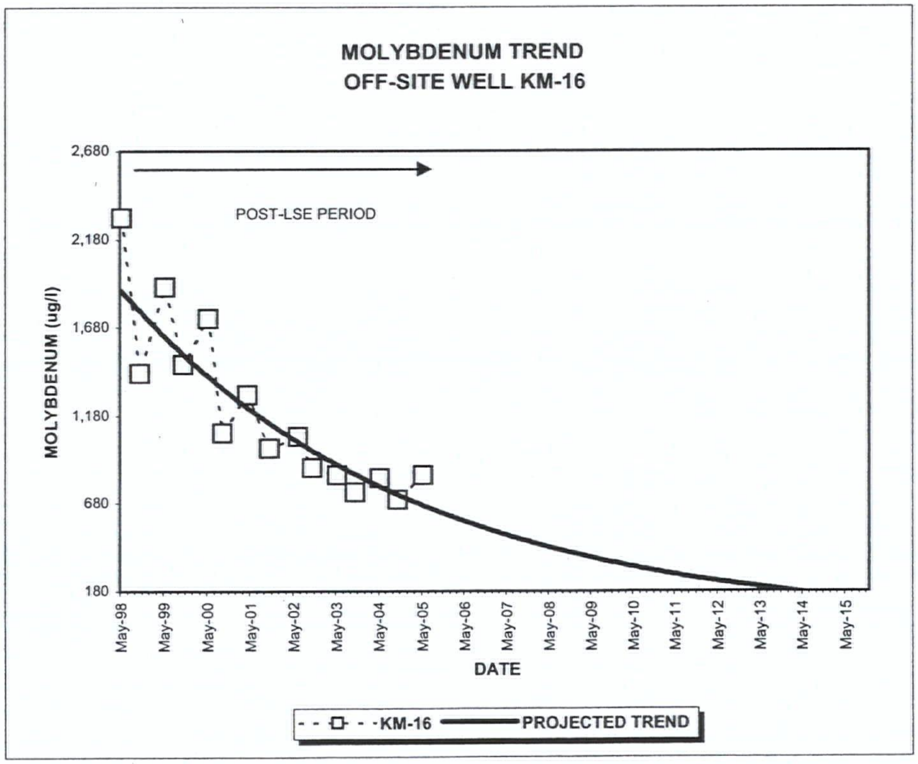




RBC FOR MOLYBDENUM IS 180 UG/L

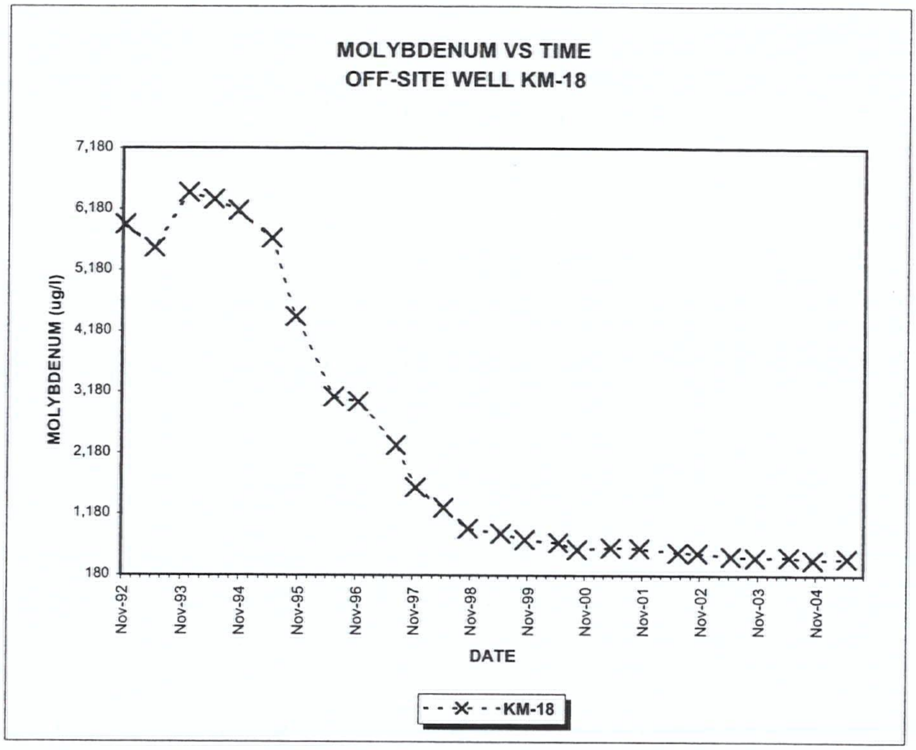
COC CONCENTRATIONS WITH TIME AND PROJECTED TRENDS

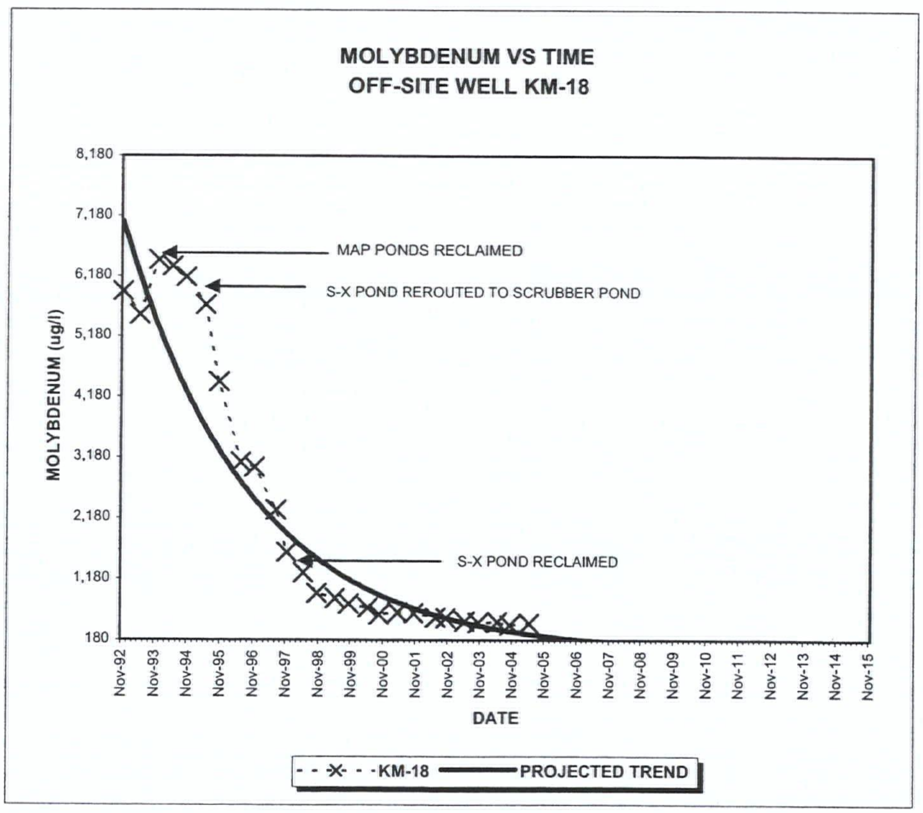




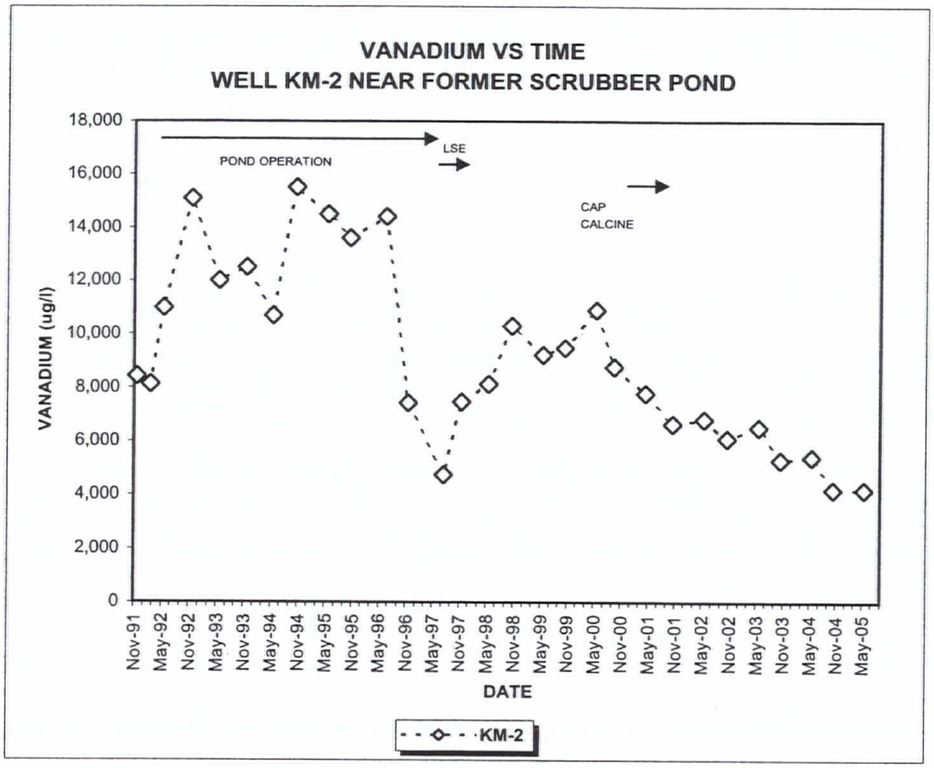
RBC FOR VANADIUM IS 260 UG/L
PROJECTED TREND BASED ON OBSERVATIONS FOLLOWING
COMPLETION OF LSE AND RECLAMATION

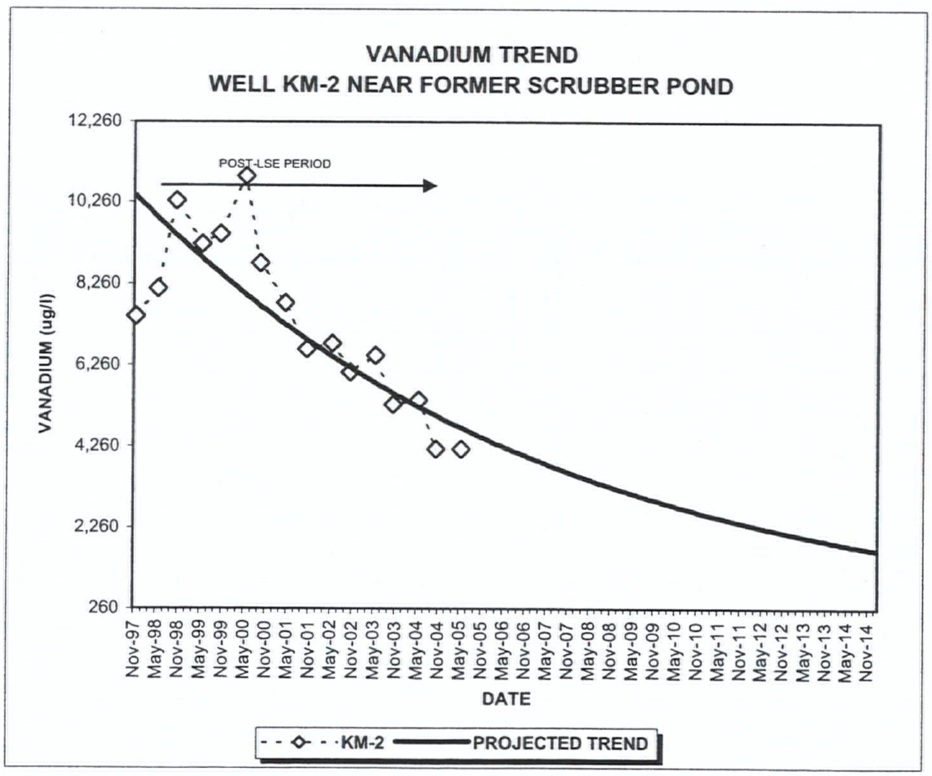
COC CONCENTRATIONS WITH TIME AND PROJECTED TRENDS



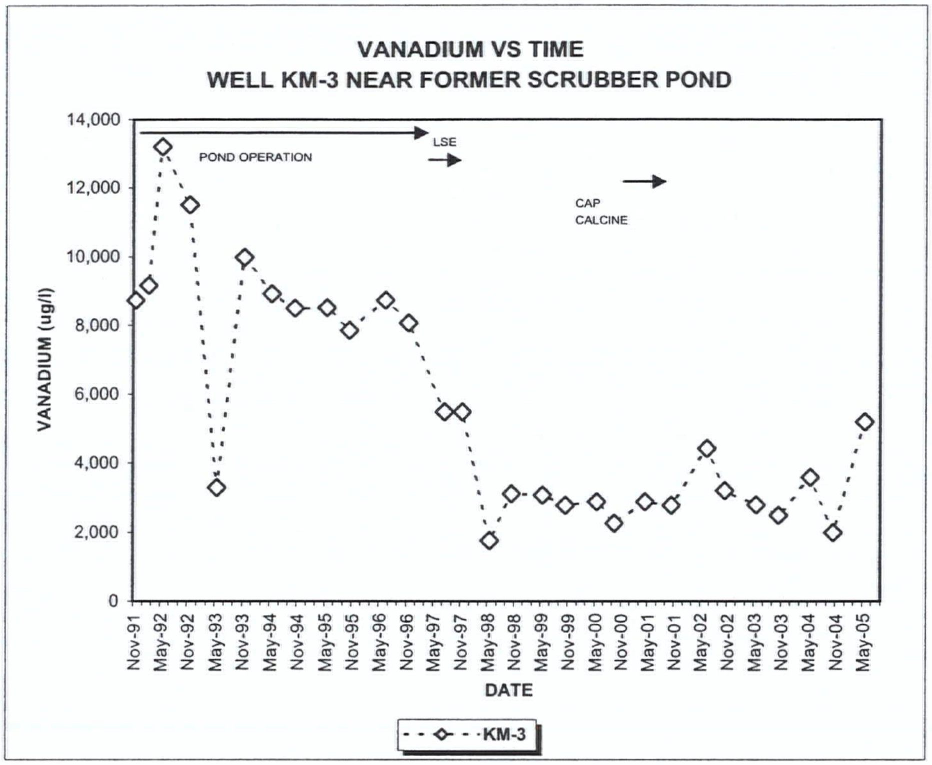


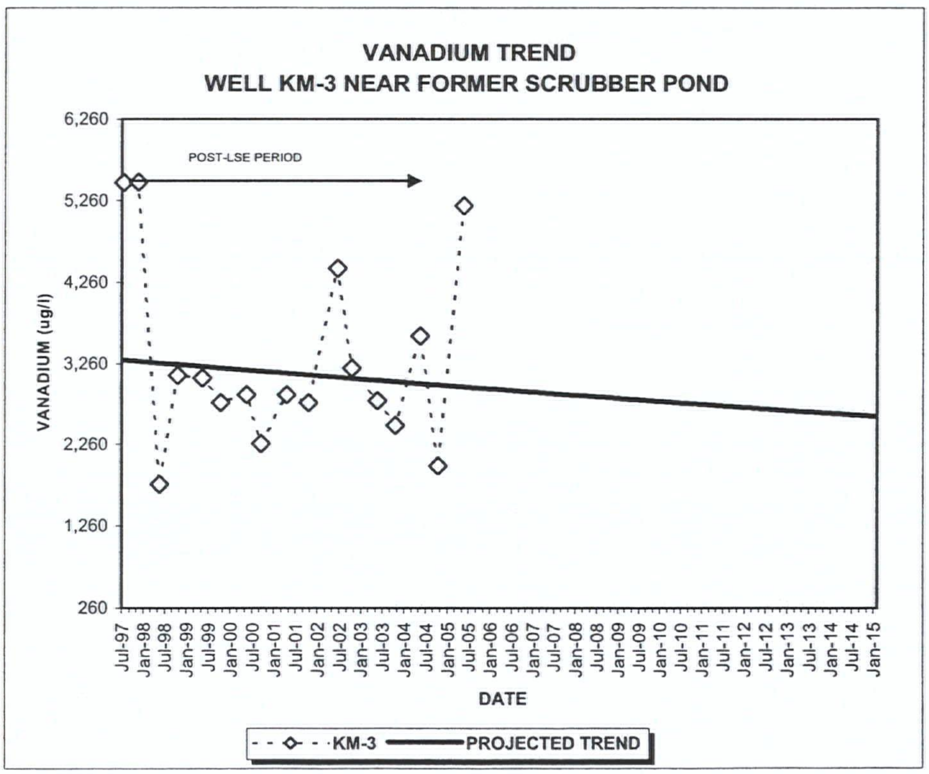
RBC FOR VANADIUM IS 260 UG/L


VANADIUM VS TIME
WELL KM-2 NEAR FORMER SCRUBBER POND
POND OPERATION
LSE
CAP
CALCINE
VANADIUM (ug/l)
0
2,000
4,000
6,000
8,000
10,000
12,000
14,000
16,000
18,000
Nov-91
May-92
Nov-92
May-93
Nov-93
May-94
Nov-94
May-95
Nov-95
May-96
Nov-96
May-97
Nov-97
May-98
Nov-98
May-99
Nov-99
May-00
Nov-00
May-01
Nov-01
May-02
Nov-02
May-03
Nov-03
May-04
Nov-04
May-05
DATE
KM-2


VANADIUM TREND
WELL KM-2 NEAR FORMER SCRUBBER POND
POST-LSE PERIOD
VANADIUM (ug/l)
260
2,260
4,260
6,260
8,260
10,260
12,260
Nov-97
May-98
Nov-98
May-99
Nov-99
May-00
Nov-00
May-01
Nov-01
May-02
Nov-02
May-03
Nov-03
May-04
Nov-04
May-05
Nov-05
May-06
Nov-06
May-07
Nov-07
May-08
Nov-08
May-09
Nov-09
May-10
Nov-10
May-11
Nov-11
May-12
Nov-12
May-13
Nov-13
May-14
Nov-14
DATE
KM-2
PROJECTED TREND

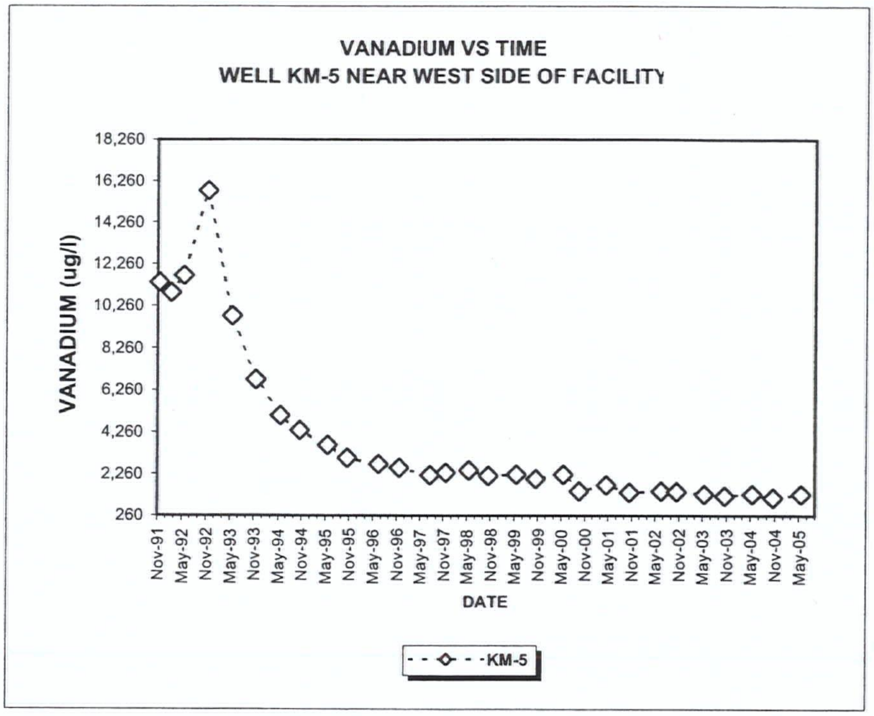
FIGURE

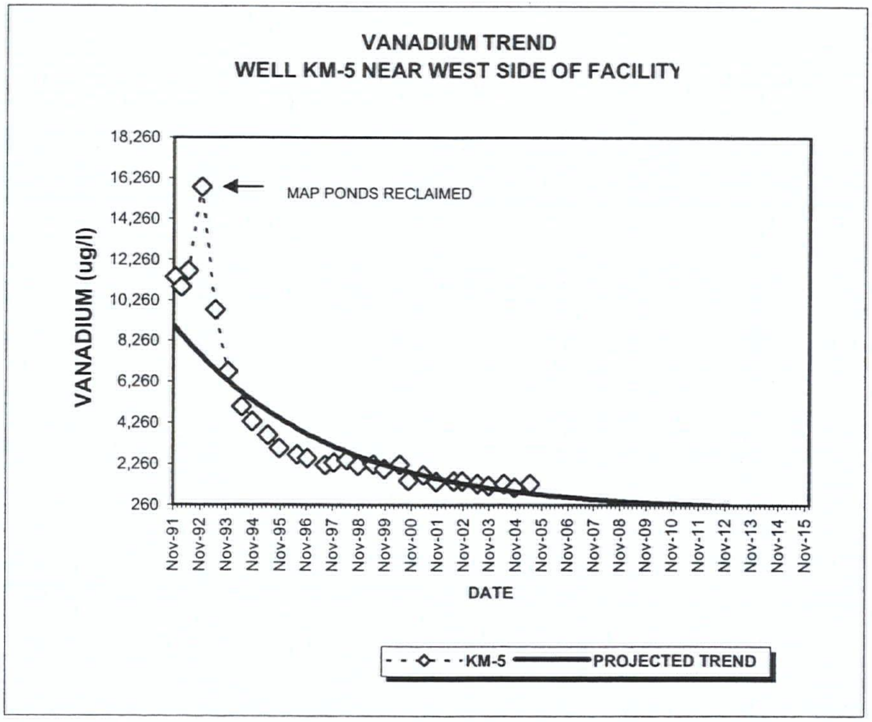

VANADIUM VS TIME
WELL KM-3 NEAR FORMER SCRUBBER POND
POND OPERATION
LSE
CAP
CALCINE
VANADIUM (ug/l)
14,000
12,000
10,000
8,000
6,000
4,000
2,000
0
Nov-91
May-92
Nov-92
May-93
Nov-93
May-94
Nov-94
May-95
Nov-95
May-96
Nov-96
May-97
Nov-97
May-98
Nov-98
May-99
Nov-99
May-00
Nov-00
May-01
Nov-01
May-02
Nov-02
May-03
Nov-03
May-04
Nov-04
May-05
DATE
KM-3


VANADIUM TREND
WELL KM-3 NEAR FORMER SCRUBBER POND
POST-LSE PERIOD
VANADIUM (ug/l)
6,260
5,260
4,260
3,260
2,260
1,260
260
Jul-97
Jan-98
Jul-98
Jan-99
Jul-99
Jan-00
Jul-00
Jan-01
Jul-01
Jan-02
Jul-02
Jan-03
Jul-03
Jan-04
Jul-04
Jan-05
Jul-05
Jan-06
Jul-06
Jan-07
Jul-07
Jan-08
Jul-08
Jan-09
Jul-09
Jan-10
Jul-10
Jan-11
Jul-11
Jan-12
Jul-12
Jan-13
Jul-13
Jan-14
Jul-14
Jan-15
DATE
KM-3
PROJECTED TREND

FIGURE

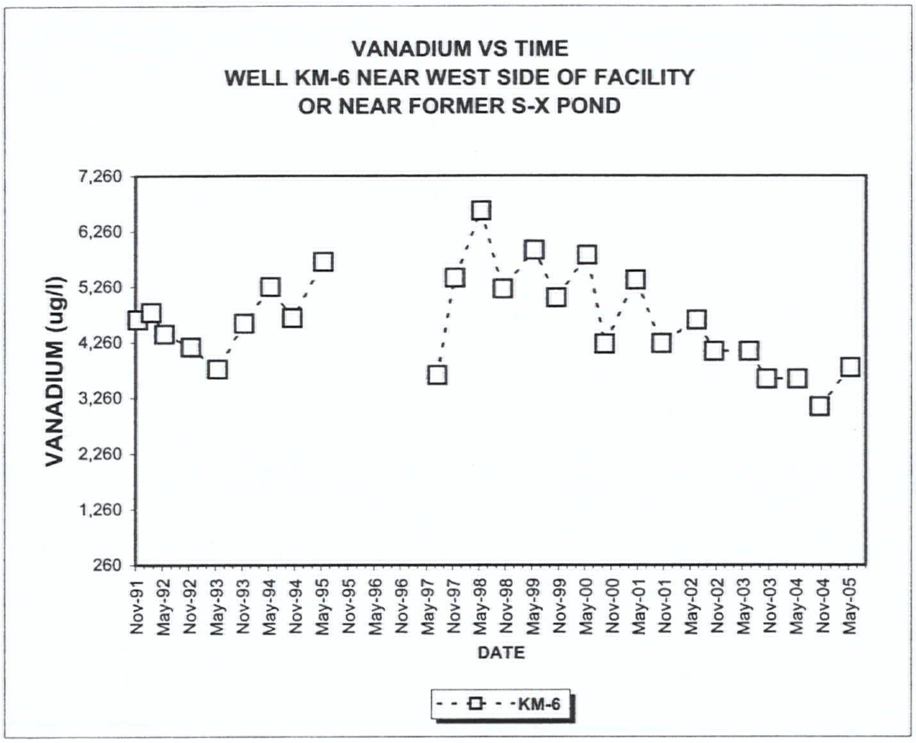
COC CONCENTRATION TRENDS WITH TIME AND PROJECTED TRENDS

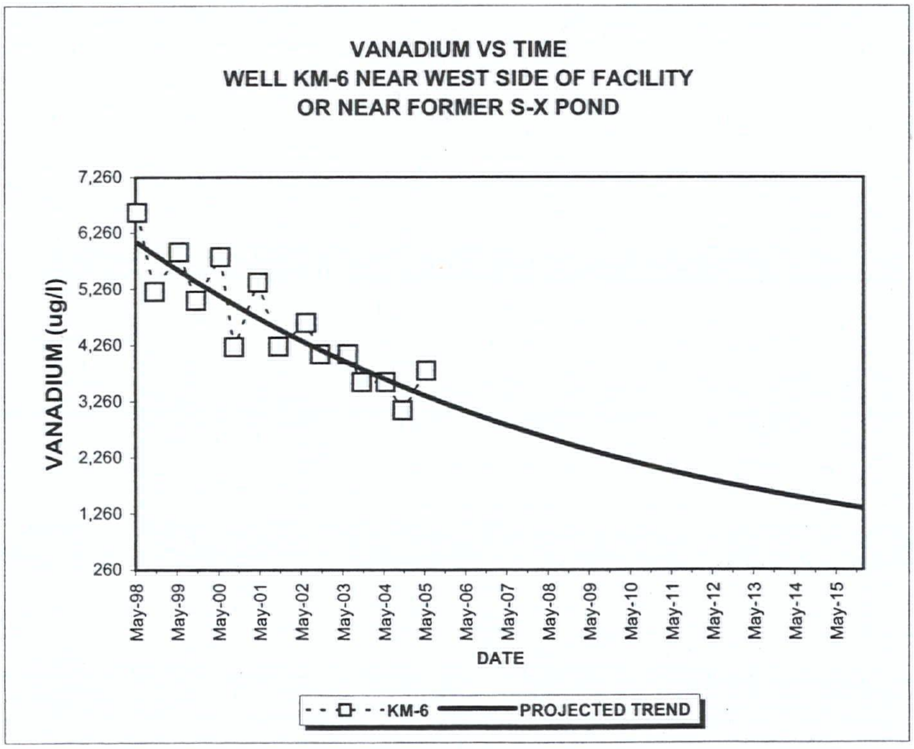




RBC FORMOLYBDENUM IS 180 UG/L
KM-5 IS A POC WELL
PROJECTED TRENDS BASED ON OBSERVATIONS FOLLOWING LSE

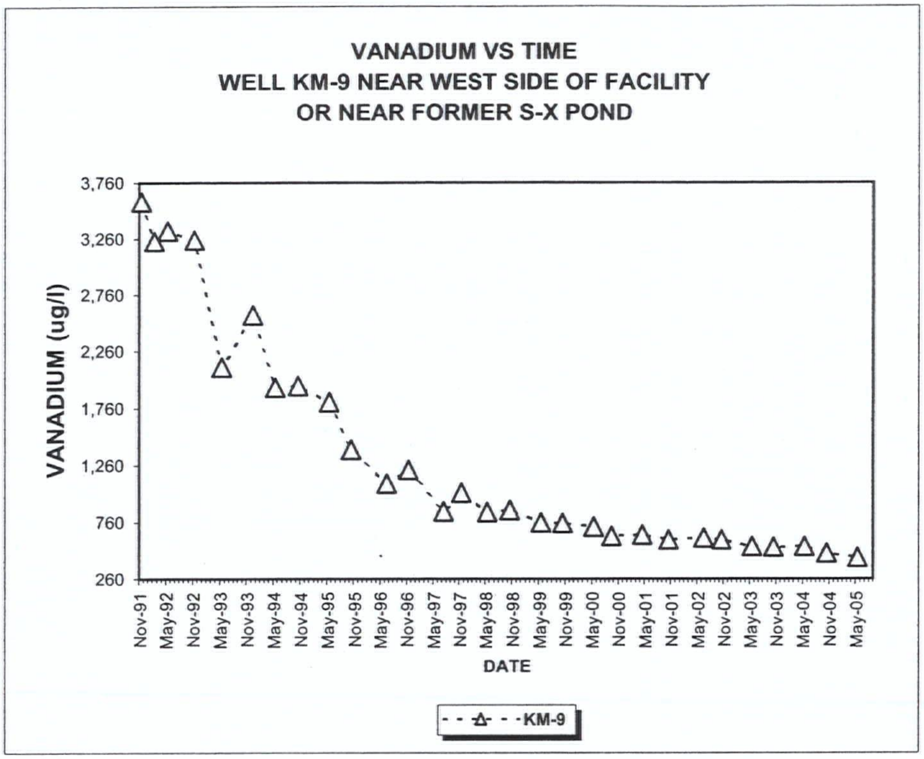
COC CONCENTRATIONS AND PROJECTED TRENDS VERSUS TIME

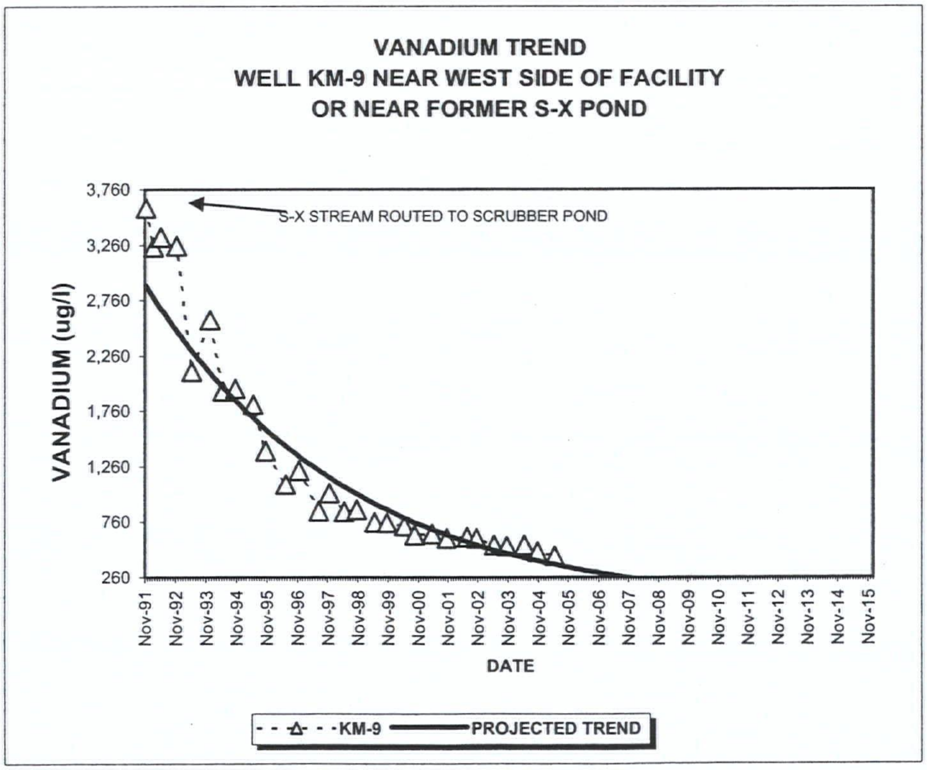




RBC FOR VANADIUM IS 260 UG/L

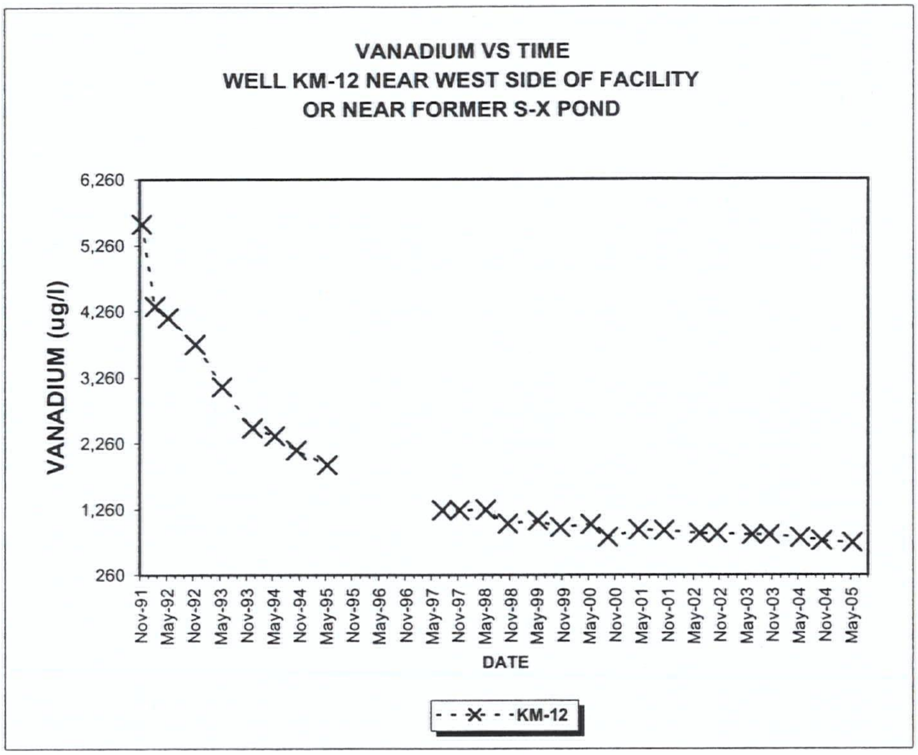
COC CONCENTRATION TRENDS WITH TIME AND PROJECTED TRENDS

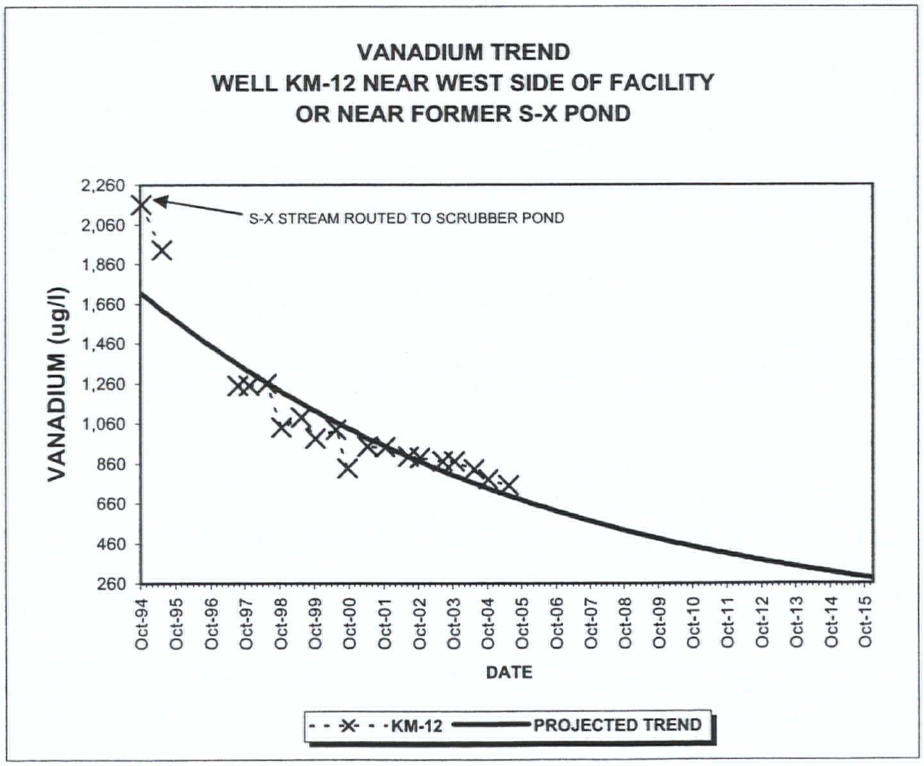




RBC FOR MOLYBDENUM IS 180 UG/L
KM-9 IS A POC WELL
PROJECTED TRENDS BASED ON OBSERVATIONS FOLLOWING REROUTING OF S-X STREAM

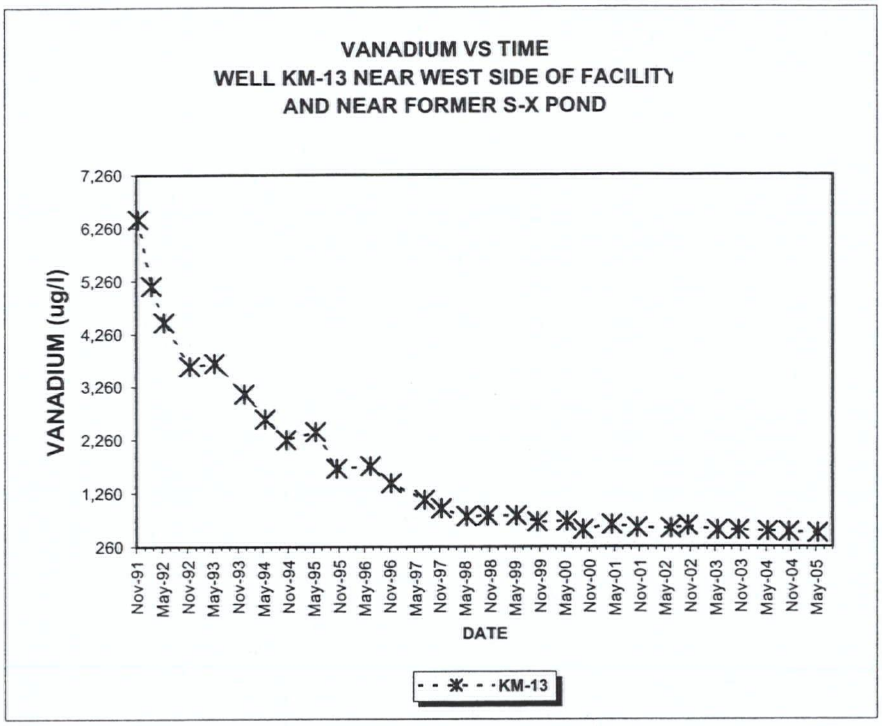
COC CONCENTRATION TRENDS WITH TIME AND PROJECTED TRENDS

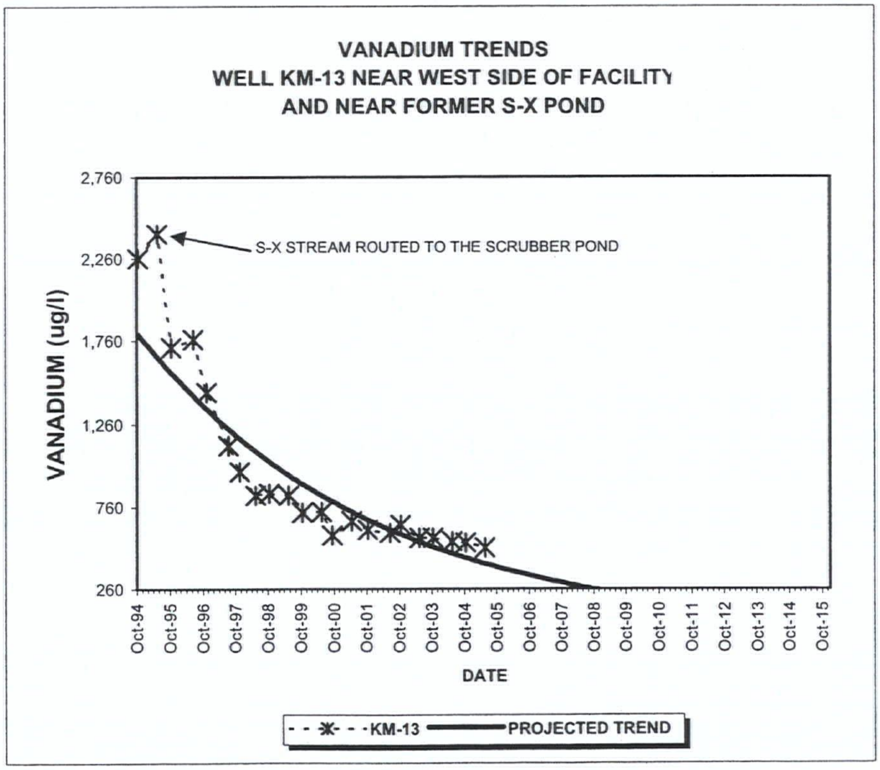




RBC FOR VANADIUM IS 260 UG/L
KM-12 IS A POC WELL
PROJECTED TRENDS BASED ON OBSERVATIONS FOLLOWING REROUTING OF THE S-X STREAM

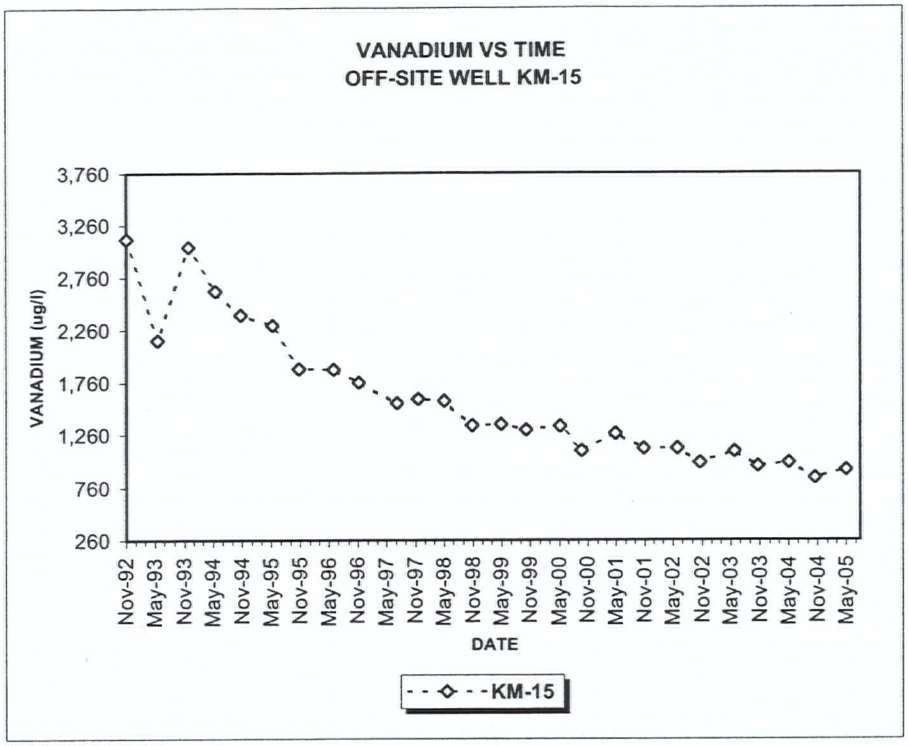
COC CONCENTRATION TRENDS WITH TIME AND PROJECTED TRENDS

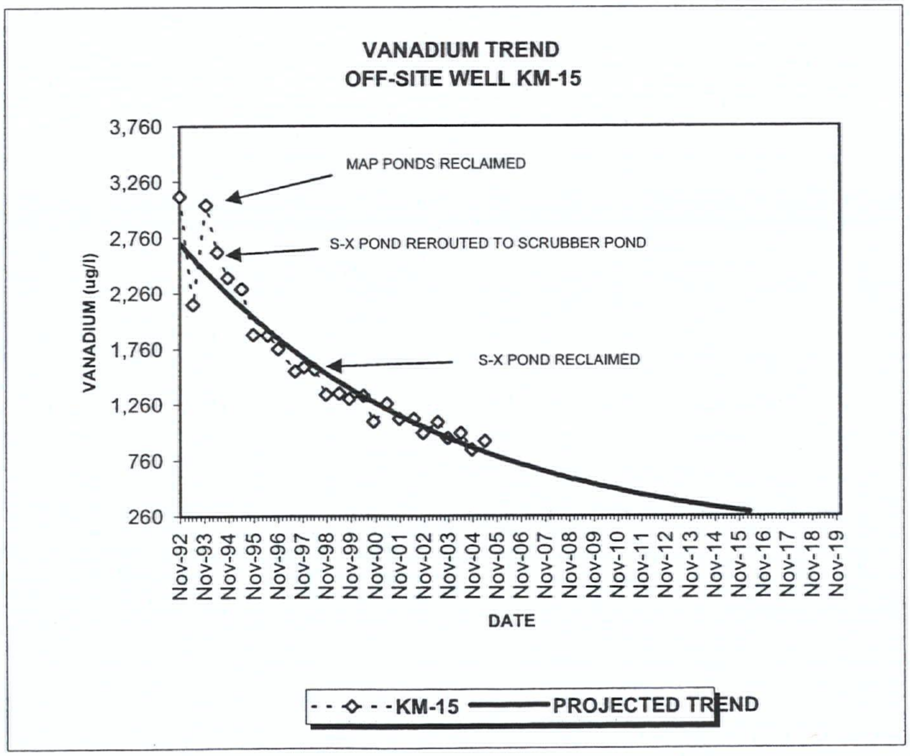




RBC FOR VANADIUM IS 260 UG/L
KM-13 IS A POC WELL
PROJECTED TRENDS BASED ON OBSERVATIONS FOLLOWING REROUTING OF THE S-X STREAM

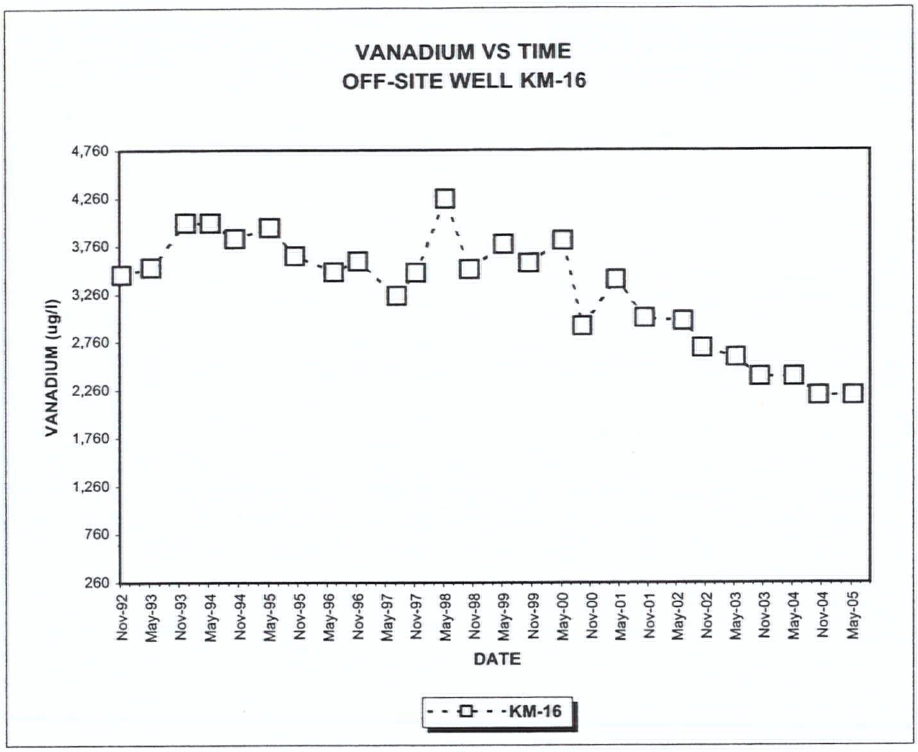
COC CONCENTRATIONS WITH TIME AND PROJECTED TRENDS

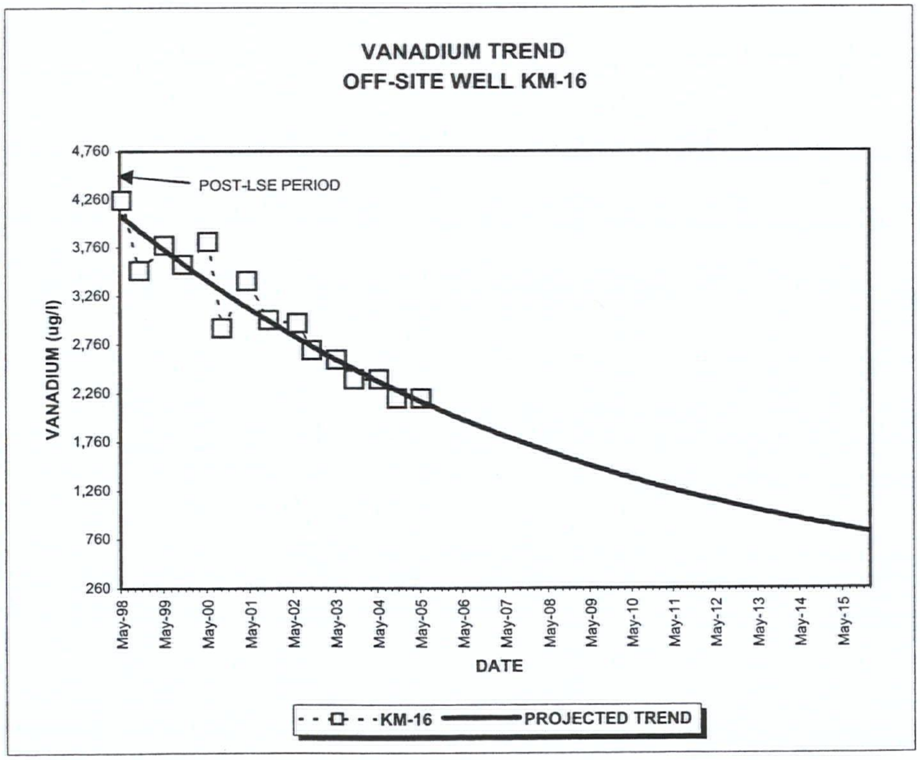




RBC FOR MOLYBDENUM IS 180 UG/L

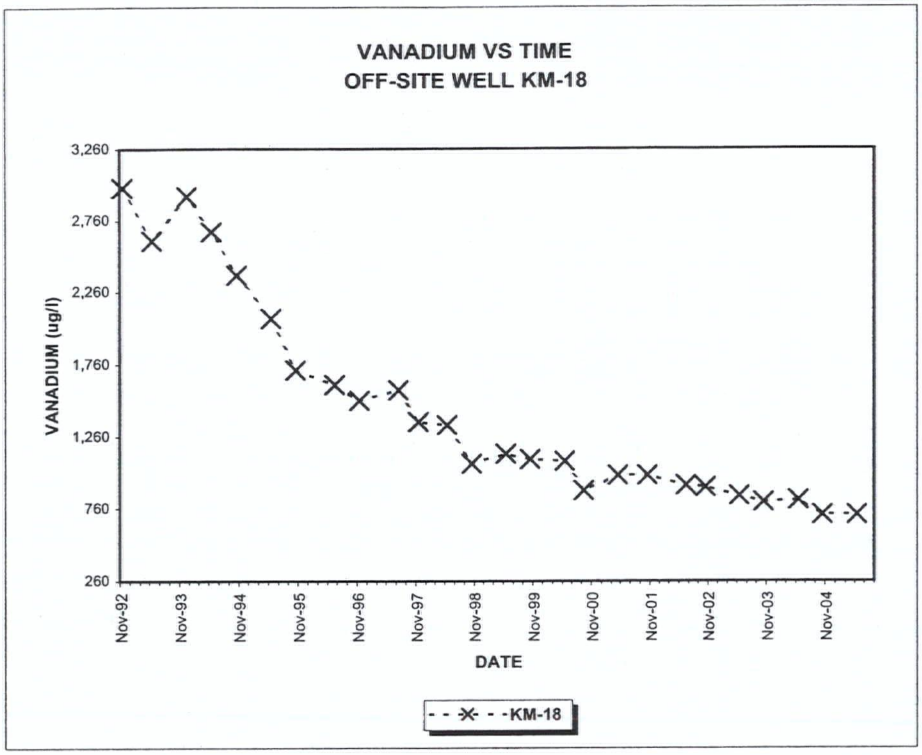
COC CONCENTRATIONS WITH TIME AND PROJECTED TRENDS

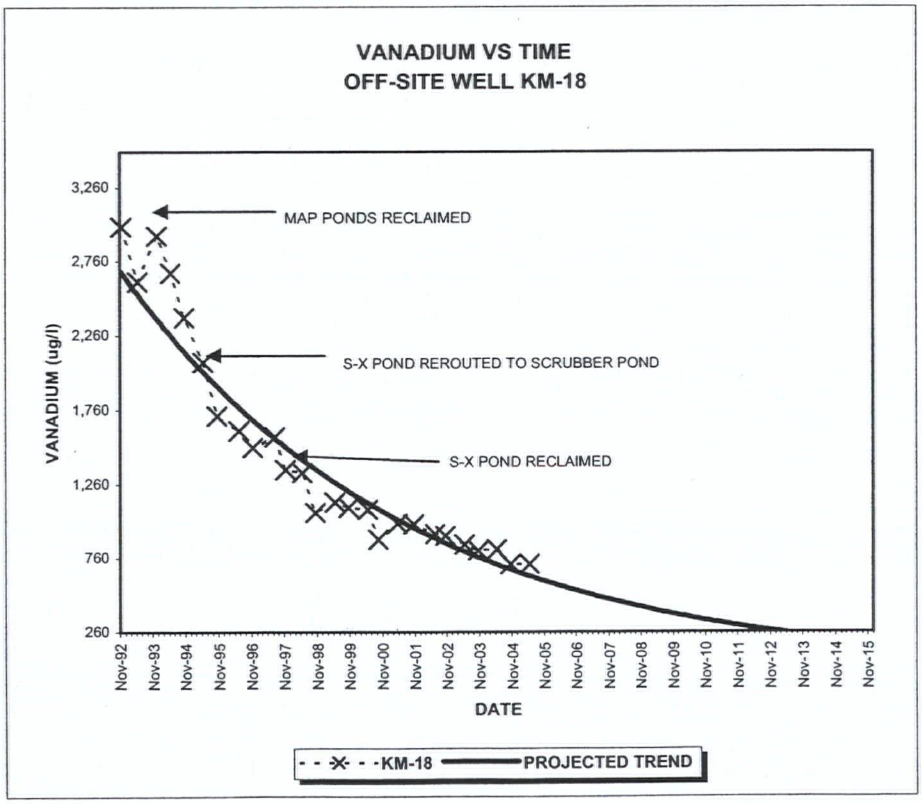




RBC FOR VANADIUM IS 260 UG/L
PROJECTED TREND BASED ON OBSERVATIONS FOLLOWING
COMPLETION OF LSE AND RECLAMATION

COC CONCENTRATIONS WITH TIME AND PROJECTED TRENDS





RBC FOR VANADIUM IS 260 UG/L